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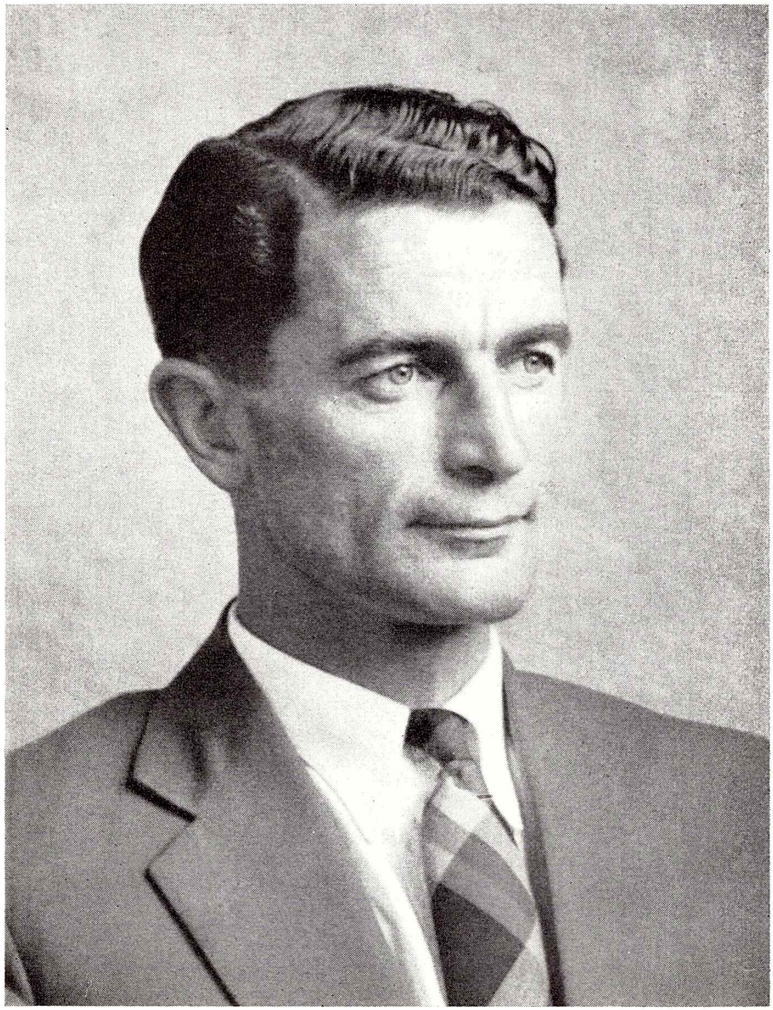

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M.Agr.Sc.(N.Z.), D.Phil.(Oxon.)

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SHEEPFARMING ANNUAL
1959

Including the Proceedings of the Twenty-second Annual Meeting of Sheep Farmers conducted by Massey Agricultural College, Palmerston North, on 30 June, 1–2 July, 1959.

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CHAIRMAN'S OPENING REMARKS

IT IS A GREAT PLEASURE to welcome you to the Twenty-second Massey Sheepfarmers' Conference. In particular, I wish to welcome Sir Geoffrey Peren, who, since the meeting twelve months ago, has been knighted in the New Year Honours List. It is a distinction which gave all of us at the College a great deal of pleasure, and I am sure you will wish me to convey to him your warmest congratulations.

The Massey Farmers' Weeks have assumed a dual purpose. The first of these is as a clearing-house for information and the second is as a social occasion. Farmers have the opportunity to see each other and, with an increasing number of them, an opportunity to see their sons at Massey College. In this respect you will be interested, and no doubt a little alarmed, at the trend of events at Massey.

During the past thirty years, the student body at the College has been composed of not more than 60 degree students at any one time and anything between 100 and 200 farming diploma students. Last year, our degree roll increased to 120 and this year to 180. It looks very much as though we will have approximately 300 degree students at the College during 1962. With limited accommodation, with no funds to increase either teaching facilities or staff, we have had necessarily to trim our sails. To meet this new situation, it has been necessary to substitute for the old two-year farming courses of four terms a one-year intensive farming course of three terms. We will require the diploma students to be 19 years of age at entry and to have had two years' farming experience prior to their arrival at Massey. In this manner we hope to meet the increasing demand for diploma education better than if we had retained the old two-year course. Unfortunately, these steps are by no means enough to meet the demand. Already more than 80 students have enrolled for the sheepfarming course of 1962. What is more, these diploma students are unlikely to get as much out of the course as their predecessors unless an active building campaign is launched in the near future. The diploma

students will be required, in the majority of cases, to live in Palmerston North and thereby miss a very large proportion of the benefits to be derived from a residential course.

Massey feels that it has a real place to play with both degree and diploma students, and it would be a tragedy if, for the sake of a new hostel plus extra teaching facilities, it was unable to cater for the recognized and ever-growing requirements of agricultural education in this country.

A. STEWART,
Principal.

CONTENTS

A Study of Fertilization in Sheep ..... *I. J. Inkster* 9

Preliminary Report on a Tupping Survey, Ashburton County, 1957–58 ..... *K. G. Haughey* 17

Some Aspects of the Gisborne Beef Cattle Fertility Survey ..... *E. D. Fielden* and *D. McFarlane* 29

Facial Eczema Research in the Department of Agriculture ..... *J. F. Filmer* 41

Facial Eczema Research in the Department of Scientific and Industrial Research ..... *A. T. Johns* 47

New Zealand-Type Mucosal Disease *R. M. Salisbury* 61

Selenium and Animal Health *C. Drake, A. B. Grant,* and *W. J. Hartley* 73

Recent Developments in Control of Some Pasture Pests ..... *J. M. Kelsey* 85

The Uses of Aerial Photography in Farm Drainage *D. G. Bowler* 89

Pasture Establishment and Management *R. W. Brougham* 95

Methods of Reducing Pasture Establishment Costs *M. W. Cross* 107

Topdress the Hills, or . . . ? ..... *Sir Bruce Levy* 119

The American Livestock Situation, with Particular Reference to New Zealand's Overseas Markets for Meat ..... *D. E. Brady* 129

The Grading of Carcasses for Export *S. H. Smith-Pilling* 149

Problems in Attaining Higher Production on a Manawatu Fat Lamb Farm ..... *J. M. Hare* 169

Space Planting for Erosion Control in Coastal Hawke's Bay ..... *H. M. Williams* 183

What's New in Electric Fencing ..... *W. R. R. Hewitt* 193

Farm Building Construction ..... *H. W. T. Eggers* 203

Recent Developments in Wool Research
G. A. Wickham 217

Some Observations on Autumn Feeding of Choumoellier ..... *G. S. Robinson* 223

The Present Position of Wheat Growing in the North Island ..... *R. H. Schwass* 229

Progress on Experimental Work on Iodine and Antithyroid Substances in Pasture Species
D. S. Flux, G. W. Butler, and *A. L. Rae* 235

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A STUDY OF FERTILIZATION IN SHEEP

I. J. INKSTER*

AT CULLING TIME, a farmer does not lump together and discard all the ewes which failed to rear a lamb in the previous season. He distinguishes between ewes which had lambs and lost them, and ewes which did not lamb at all. He distinguishes between two-tooths and older ewes, and also ewes which had bearing trouble or bad udders. Similarly, when a scientist is studying an infertile class of sheep, such as two-tooths tend to be, he tries to classify the dry ewes according to the reasons for their fertility failure. In its fullest sense, fertility is the end result of a long chain of events which, in the ewe, starts in the ovaries and finishes at weaning. If one link in this chain breaks down, whether an early one or a late one, and the ewe fails to rear a lamb, she must be classed as infertile. The underlying philosophy of all research on sheep fertility at Ruakura has been to examine the fertility chain, link by link, to identify the ones which tend to break down, and to look for ways of reinforcing them. In the main, this paper deals with a study of the events occurring in a ewe after she has been served by a ram.

Three topics will be discussed. First, the process of fertilization using some illustrations, secondly, a field trial which gave an interesting result, and, thirdly, a study on fertilization which helps to explain the results of the field trial.

The Process of Fertilization

Figure 1 illustrates the breeding tract of a ewe. The vagina or bearing has been removed to show the cervix. The cervix leads into the uterus, consisting of two horns, each tapering into a fine tube. Near the end of each tube is an ovary. On the top ovary in Fig. 1 there is a blister-like swelling, called a follicle, which contains a developing egg. Three or four days before a ewe comes on heat, one or more follicles start to increase in size, and near the end of the heat burst and release an egg or eggs into a large funnel on the end of the tube. In the crater of the burst follicle, a new structure called a corpus luteum begins to develop, and this increases in size until at about ten days after ovulation, it is the

**Ruakura Hill Country Research Station, Private Bag, Frankton Junction.*

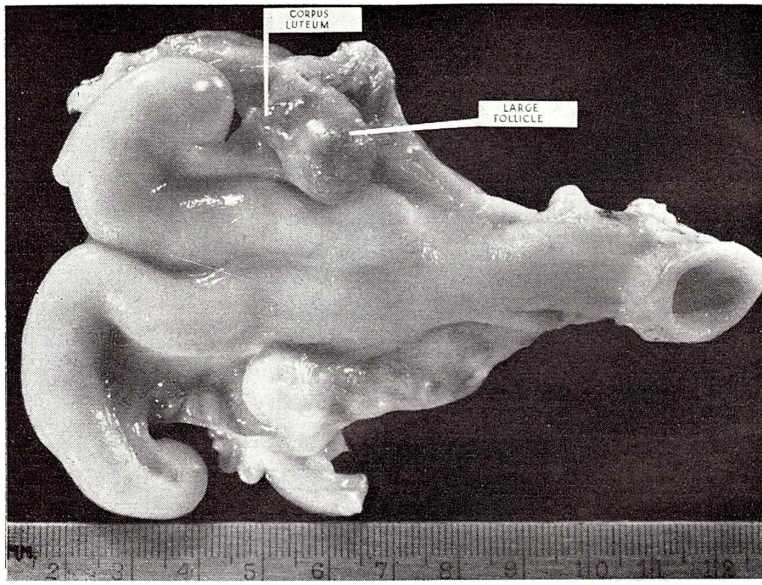

Fig. 1: *The uterus and ovaries of a ewe.*

size of a pea. If the ewe becomes pregnant, this corpus luteum will remain until the end of pregnancy. If conception does not occur, the corpus luteum rapidly shrinks, new follicles grow, and the ewe comes on heat again, approximately seventeen days after her last heat period.

Figure 2 is a photograph of an egg, greatly magnified. The sheep has a larger egg than other mammals, yet it is only about 1/150 in. in diameter, and can be seen only with a microscope. Figure 3 shows some sperms, even more highly magnified. Each sperm consists of a head and a whip-like tail which can move it along. As a rough guide to their size, one can calculate that a chain of 4,000 sperms laid head to tail would be about an inch in length.

The ram deposits semen at the cervix and the sperms pass through into the uterus and up the tubes, partly as the result of their own swimming movements, and partly assisted by the contractions of the tract of the ewe. The journey may take from fifteen minutes to several hours. If service has been correctly timed, the sperms meet the egg at the top of the tube. Many may penetrate the outer membrane. However, only one sperm passes through the inner membrane, and the material in the head joins with that in the centre, or nucleus, of the egg—this con-

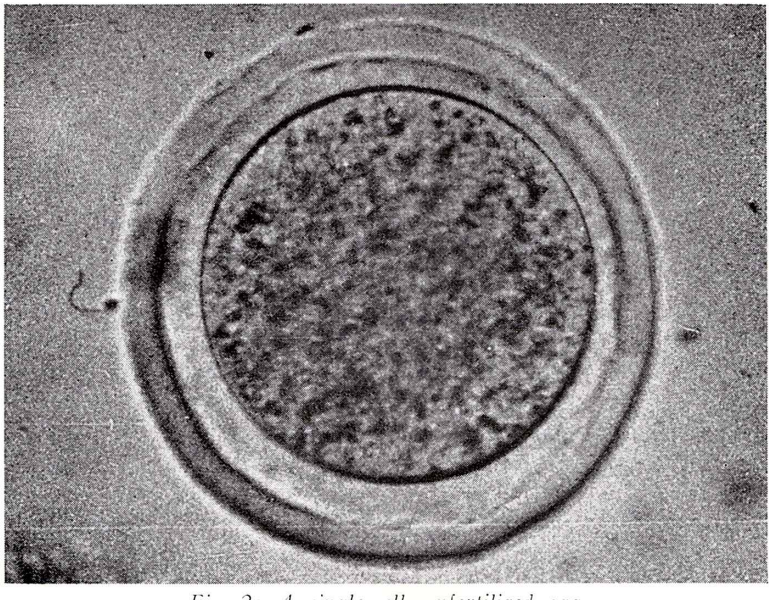

Fig. 2: A single-cell, unfertilized egg.

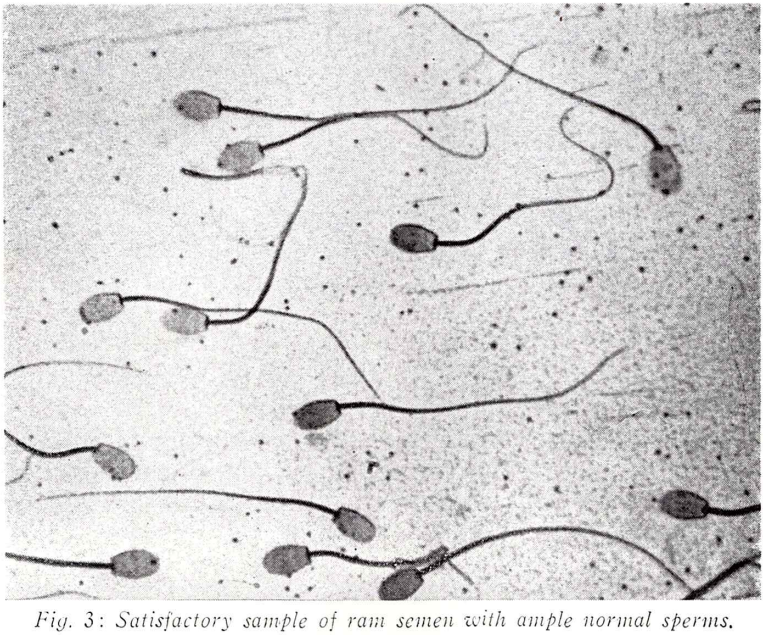

Fig. 3: Satisfactory sample of ram semen with ample normal sperms.

stitutes fertilization. For it to occur, the ewe must produce a normal egg, and she must meet and mate with a fertile ram so that adequate numbers of sperms are present at the upper end of the tubes at the right time. In addition, the tubes must provide a suitable environment.

The fertilized egg travels slowly along the tube, the journey taking about three days, and, during this time, the fertilized egg starts to divide. At about twenty-four hours after fertilization, the egg splits into two cells (Fig. 4, left); these split again into four (Fig. 4, right), then into eight, sixteen, thirty-two, and so on. When the divided egg enters the uterus, further cell divisions occur, followed by complicated re-organizations to form an embryo. If this development proceeds normally, the corpus luteum in the ovary persists and the ewe does not return to service. If, however, the development of the egg is arrested soon enough, the corpus luteum will shrink, more follicles will ripen, and the ewe will have a heat period approximately seventeen days after the last one. A low conception rate is caused by either a low percentage of fertilized eggs, or a high failure rate in the early stages of embryonic development.

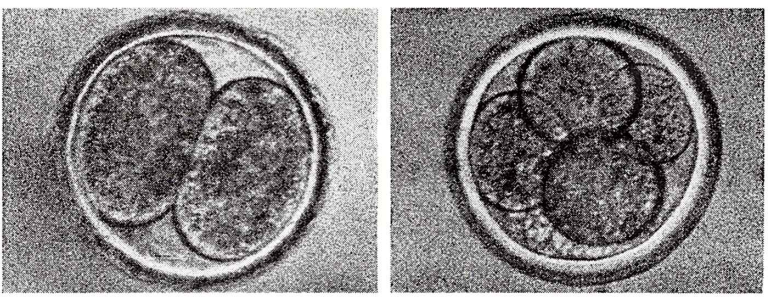

Fig. 4: *A fertilized egg at the two-cell stage* (left), *and the four-cell stage* (right).

Effect of Pre-mating Shearing on Two-tooth Lambing Performances

It has frequently been claimed that the shearing of two-tooth ewes prior to mating will result in an increased lambing percentage. On the Waikeria Prison farm in 1958, a large-scale trial was conducted to test this. Approximately half of a mob of 1,100 two-tooth ewes were shorn immediately before the rams were turned out (February 28) and the shorn and unshorn sheep were run together thereafter. At lambing, lambed ewes were

shed regularly and ewes which lost their lambs were removed and run separately. The results are shown in Table 1.

These figures in Table 1 show a difference of 16.1 per cent. in favour of the shorn sheep in the percentage of ewes having a lamb (alive or dead). In addition, from a consideration of the ratio of shorn to unshorn sheep in the docking paddocks, it was possible to demonstrate that, on average, the shorn ewes lambed earlier than the others. The figures indicate that shearing had quite a clear-cut effect on the ewes—the question then arises, how was this effect produced? This year, three different experiments have been designed to throw more light on this question. Information from only one is available at present, and the interim findings of this one must, of course, be confirmed at lambing.

TABLE 1: Lambing Performance of Two-tooth Ewes, Waikeria, 1958.

	Shorn	*Unshorn*
No. mated	594	516
Percentage rearing lambs	81.6	60.2
Percentage losing lambs	12.0	17.3
Total percentage lambing	93.6	77.5

Study on Fertilization

An even line of 300 October-born two-tooths was divided into two similar groups on March 6 and one group was shorn. The shorn and unshorn ewes were then combined and run with raddled rams. As the ewes of each group came on heat, they were allotted alternately to either a slaughter group or a control group. The ewes in the slaughter group were killed 2 to 4 days after they were served by the ram, their reproductive tracts removed, and the eggs were washed out of the tubes and examined under a microscope to determine whether fertilization had occurred. The control group ewes rejoined the mob so that the percentage returning to service could be determined. These ewes will run through until weaning when it will be possible to calculate the percentage of ewes lambing, the number of lambs born, and the weaning weights of the lambs.

By comparing the data obtained from the slaughter and control groups it is possible to determine the phase or phases of repro-

duction at which the difference in fertility between shorn and unshorn two-tooths arise.

Table 2 shows the information obtained so far.

TABLE 2: A Comparison of Some Phases of Reproduction in Two-tooth Ewes, Ruakura Outstation, 1959.

	Shorn	*Unshorn*
Average date of first service	March 29	March 29
Average number of eggs shed per ewe	1.10	1.35
Percentage of ewes with fertilized eggs	83.9	82.4
Percentage holding to first service	80.8	54.9
Percentage holding to second service	85.7	59.4

The interesting thing about this table is the comparison between the fertilization rate in the slaughter group and the conception rate (measured as percentage holding to service) in the control group. The shorn and unshorn ewes had practically the same fertilization rate, as measured 2 to 4 days after mating, but a considerably different conception rate, as measured approximately 17 days after mating.

In the first part of this paper it was shown how a low conception rate could be caused either by a low percentage of fertilized eggs, or by a high failure rate in the early stages of embryonic development. If the data just presented give a true picture of the situation, one must conclude that the shearing of two-tooth ewes in some way increases the survival chance of their fertilized eggs. The findings at Waikeria in 1958 were that more of the shorn two-tooths lambed, and that they lambed earlier. If the higher conception rate demonstrated in the last experiment is a general characteristic of shorn two-tooths, then it is an adequate explanation of the results obtained at Waikeria.

The fact that pre-mating shearing would seem to have its effect after fertilization is more important to the physiologist than to the farmer. The question relevant to this discussion is whether the shearing of two-tooth ewes before mating is likely to lead to an improvement in lambing percentage under all conditions.

It would be unwise to generalize because of the large number of factors which could complicate the issue. The differences might show in one season, but not in another; shearing might be beneficial for ewes on one class of country or type of feed, but not for ewes under different conditions. The results might depend on the previous shearing history of the ewes under consideration. Further work will throw light on these factors. Nevertheless, several good farmers have followed the practice for a number of years and claim excellent results. It may be that farmers who are experiencing trouble with two-tooth fertility, may consider pre-mating shearing worth trying. The results have been presented not as practical recommendations, but merely as examples of some of the fertilization studies which are being conducted at Ruakura.

Acknowledgements

The co-operation of the Department of Justice in providing facilities for this investigation at Waikeria is gratefully acknowledged. J. F. Carver and E. H. Latimer at Waikeria gave invaluable assistance.

DISCUSSION

Q:: *Does flushing affect ovulation rate and fertilization?*

A:: The main effect of flushing is to increase the ovulation rate and, as a result, to increase the number of lambs born. It also has the effect of slightly lowering the conception rate, but it is not known whether this is due to an adverse effect on fertilization, or on the development of the fertilized egg.

Q:: *Could the difference in ovulation rate be the result of the shorn ewes being healthier?*

A:: Since the ovulation rate in the shorn ewes was lower than that in the unshorn I do not think this is likely.

Q:: *What is the optimum interval between shearing of the ewes and the start of mating?*

A:: The interval between shearing and the start of mating was one day in the Waikeria experiment and eight days in the Ruakura experiment. No other intervals have been tried. Table 2 indicates that, in the Ruakura experiment, the conception rate at the second service was similar to that at the first. This suggests that the effects of shearing are not short term, so that the sheep could possibly be shorn up to a month before mating. Further work is planned to throw light on this point, and also to investigate whether the time of shearing as a hogget affects the results.

Q:: *What is the difference in the number of ewes producing twins between the shorn and unshorn groups?*

A:: This will be estimated at Ruakura this year, but it was not possible to obtain the information at Waikeria. Since the incidence of twinning was low, however, one would not have expected to find significant differences at Waikeria.

Q:: *The pre-mating shearing of two-tooth ewes leads to shorter wool. What effect would this have on the market value of these short wools?*

A:: The length of wool obtained at pre-mating shearing of two-tooths is determined by the time the ewes were shorn as hoggets. I am not qualified to predict what the value of shorter wools will be.

Q:: *Have you any data on lambing difficulties, bearing trouble, etc., between the shorn and unshorn groups?*

A:: These data will be collected at Ruakura this year. It is interesting to notice that, at Waikeria, five per cent. more of the unshorn ewes lost lambs than the shorn (Table 1).

Q:: *Do two-tooth ewes eat more after shearing?*

A:: Yes—but this is probably not of long duration.

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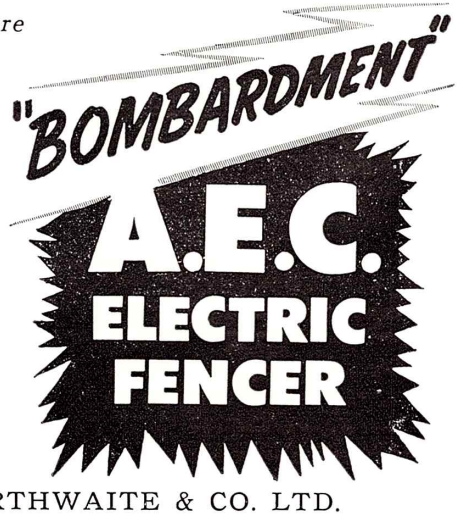

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PRELIMINARY REPORT ON A TUPPING SURVEY
Ashburton County 1957-58

K. G. HAUGHEY*

THIS IS A PRELIMINARY REPORT on some of the observations made during the tupping survey carried out by the Ashburton Veterinary Club with the co-operation of a number of farmers during the years 1957-58. The work is as yet in its initial stages. Some of the observations made are not in accord with currently held views, and need a considerable amount of testing. Unfortunately the work has been suspended—temporarily it is hoped—the cost of such a project being too great to be borne alone for more than a short period by the organization concerned.

Readers are warned against drawing conclusions too hastily from the data presented.

Introduction

Assuming that pastures are available to feed animals, probably the next most important factor within the livestock industries is an effective reproduction. It is the basis of providing the raw materials for market. Over many years countless scientists have examined many aspects of reproduction. When it comes to sheep, very little information appears to be available on one aspect of their breeding behaviour, namely mating management. In effect this means there can be little or no sound basis for some of the current recommendations relating to management of the sheep flock at mating.

Optimal mating management could be defined as that system which achieves the highest possible proportion of pregnancies per 100 ewes mated, preferably at the highest level of fertility compatible with the particular environment. That is, all sheep farmers want every ewe in lamb, hill country farmers wanting less twins than fat lamb farmers, owing to differences in feed supply.

As a prelude to setting up field trials to study and compare different systems of mating it was first necessary answer two questions.

(1) How many ewes can the "average" ram mate effectively under paddock conditions?

**Ashburton Veterinary Club, P.O. Box* 131, *Ashburton.*

(2) How long does the "average" ram last under paddock conditions?

To this end, a series of field trials were set up with the co-operation of a number of farmers.

During 1957, trials were carried out on 18 properties and in 1958 22 trials were carried out on 21 properties. Forty rams and 12,000 ewes have been involved to date. In addition, observations were made on 15 replacement rams.

Materials and Methods

Rams

Breed of Ram: Twenty-four test matings were carried out using Romneys, 13 involving Southdowns, one involving a Border Leicester, and two involving rams of the South Suffolk breed. A number of rams were used in both seasons.

A preponderance of Romney and Southdown rams was selected because these two constitute the main breeds used in this country.

Age of Ram: Rams of all ages were used. Seventeen of the rams used were shearlings, eight were two-shear, six were three-shear, six were four-shear, two were five-shear, and one was a six-shear ram.

During 1958 a preference was given to shearling rams so that a study of lifetime performances could be commenced.

Selection of the Ram: This was carried out by the co-operating farmer. Provided the ram satisfied examinations for epididymitis and semen quality it was accepted. On only one occasion was a ram discarded, probably unnecessarily.

Management of the Ram: Each ram was subjected to the particular farmer's usual pre-mating management. No concentrates were fed.

Ewes

Breed of Ewe: Mainly Romney and Corriedale.

Age of Ewe: Two-tooths were excluded as Ruakura work indicates they are shy breeders. During 1958 a preference was given to four-tooth ewes to allow for observations on lifetime performance of shearling rams with the same flock of ewes.

Management of Ewes: Each farmer practised his usual pre-mating management.

METHOD

Approximately 300 ewes plus the necessary male(s) were observed over a mating period of 54 days. The survey ram was run with the flock for the first 18 days and was usually replaced by one ram—on a few occasions two rams were used—which ran with the flock till the end of the observed period. Tupping paste was used, the colour being changed each 18 days. The ewes, as mated, whether first service or return to service, were counted and marked distinctively each six days for the first 36 days. Semen samples were collected from the rams and examined at these periods also. On the 54th day the flock was tagged with plastic ear tags into three groups as follows:

Group 1: Ewes holding to service 0 to 18 days.
Group 2: Ewes holding to service 19 to 36 days.
Group 3: The balance of the flock.

The accuracy of the mating figures was checked at lambing. The number of ewes of each ear tag colour lambing daily was recorded, together with the total lamb drop for the day. Dry and dead ewes were also recorded.

Joining Dates

During the 1957 season, these ranged from 19 February to 18 April, and in 1958 from 17 March to 16 April. The reason for the later joining dates during 1958 will be explained below.

Paddock Size and Size of Ewe Flocks

During both years the average paddock size was 19 acres, with a range of 12 to 33 acres. All paddocks were flat. Mean flock size was 294 ewes with a range of 200 to 367 ewes.

Observations Relating to Rams

First, a few words in general about the breeding behaviour of sheep. As every sheep farmer knows, ewes are seasonal breeders. It is not so well appreciated that ewes of different breeds have slightly different breeding seasons, *e.g.*, Corriedale ewes breed earlier in the season than Romney ewes. Ewes do not normally take the ram unless they are experiencing a heat. Therefore the mating performances of rams will be determined by the number of ewes experiencing heats, which is related to the time of the year. Thus, if rams are mated early in the breeding season,

relatively few ewes are experiencing heats and therefore the ram's mating performance will be comparatively low. If rams are joined when every ewe is "cycling", or experiencing heats, the ram's mating performance will be high. To illustrate this, one ram under survey joined with 300 Romney ewes on 3 March mated 24 ewes in the first 18 days, 204 ewes in the second 18 days, of which 167 ewes were marked in the last twelve days of the second period.

TABLE 1: Comparison of Survey Ram Tupping Performances in 1957 and 1958.

	1957	*1958*
Number of flocks	16	22
Mean flock size (ewes)	293	295
Mean number of ewes mated 0 to 18 days	205	222
Mean number of ewes settled	161	159

The figures in Table 1 show the number of ewes mated and settled to 18 days' mating. The mating performances for 1958 are slightly higher than 1957 because the rams were joined later in the season. Tables 2 and 3 set out the performances more clearly.

Two of the three rams leaving less than 100 ewes in-lamb following 18 days' mating were used in flocks of Romney ewes

TABLE 2: Mating Performances, Survey Rams (Both Years) 0 to 18 days.

No. Ewes Mated 0 to 18 days	*No. Rams in Class*
Over 300	1
276-300	1
251-275	4
226-250	10
201-225	7
176-200	11
151-175	2
126-150	—
101-125	2
Less than 100	2
Total rams	40

TABLE 3: Numbers of Ewes Lambing to Eighteen-day Mating, Survey Rams (Both Years)

No. Ewes Lambing	*No. Rams in Class*
Over 250	1
226-250	2
201-225	4
176-200	5
151-175	11
126-150	7
101-125	7
Less than 100	3
Total	40

early in March before many ewes were cycling. The other ram was joined with a three-quarter-bred flock on 19 February.

Performances of Replacement Rams, 1958

During 1957 little attention was paid to the performance of replacement rams, but in 1958 a more accurate check was kept on their performances. It is also worth mentioning in passing that, in 5 of the 40 test matings made to date, the survey rams mated successfully the whole flock of 300 ewes in what appeared to be no longer time than it would have taken the customary six rams—two of the rams achieving this feat in both years. While the numbers involved are small, an interesting comparison can be made between replacement rams run at different rates.

TABLE 4: Replacement Ram Performances, 19 to 36 days, 1958.

Number of replacement rams	*Nil*	*One*	*Two*
Number of flocks	2	15	5
Mean number of ewes mated	78	117	130
Mean number of ewes settled	71	98	110
Mean return rate (per cent.)	5.8	17.5	15.4

Table 4 is not presented to indicate the desirability of mating one ram to 300 ewes but it does give an idea of the efficiency of some rams. Although the numbers involved are small, it would perhaps indicate that there was no advantage to be gained from running two replacement rams as opposed to one.

Evidence is available that, while the libido of shearling rams is as great as that of older rams, a lesser proportion of ewes hold to them. The factors controlling this behaviour on the part of shearling rams are unknown at this stage. It may well be that shearling rams need different management to achieve better conception rates.

Observations Relating to Ewes

The survey, while designed initially to observe ram performances, allowed also for some observations on certain aspects of ewe breeding behaviour. Data on one such aspect may be of interest to readers.

Relationship between Times of Mating and Conception, and Lambs Born per 100 Ewes Lambing

A New Zealander, Dr R. W. L. Averill, when working at Cambridge with a small number of ewes, reported in 1955 an increase in the number of eggs shed per heat as the breeding season progressed. Since that time Dr Averill has confirmed this phenomenon in New Zealand. D. S. Hart, at Lincoln College, has made similar observations over the last two or three years. More recently, D. McFarlane at Gisborne has reported similar findings as has M. F. McDonald (*Sheepfarming Annual*, 1958). These workers have recorded an increase in the number of eggs shed per heat, reaching a peak eight to ten weeks after the occurrence of the first heat of the new breeding season. This peak lasts four to six weeks and then declines.

The very important inference of these observations is that, during the peak period of egg shedding, an increase in the number of eggs available for fertilization must result in increased ewe fertility if mating and conception take place during that time.

Table 5 confirms these observations in terms of lambs born per 100 ewes lambing, based on differences in times of mating and conception within the Ashburton County during 1957.

Table 5: Lambs Born per 100 Ewes Lambing Compared with the Date of Joining (1957).

Dates Rams Joined	*5 to 25 March*	*27 March to 18 April*
Lambs dropped per 100 ewes lambing	131	149

Table 5 does not set out the position clearly as, in point of fact, the increase in fertility is transitional, reaching a peak for Corriedale ewes about 20 March and about 3 to 4 April for Romney ewes. Differences in time of joining rams may explain in large measure the differences in fertility between North and South Island ewe flocks.

Discussion

The above is a very brief outline of some of the observations made during this survey. At this early stage it can be said that two important observations are emerging.

(1) That the average ram under paddock conditions, on country similar to the Ashburton County, *i.e.*, paddock size not exceeding 35 acres and more or less flat, can mate considerably more ewes, other than two-tooths, than is generally accepted.

(2) Time of joining ewes and rams appears to affect the fertility of the ewe flock; this observation confirms the findings of workers measuring egg-shedding rates.

At this stage it would obviously be foolish to attempt to draw definite conclusions from this work. However, if the mean performances of the rams concerned, 40 in all, are such that 160 ewes lamb to 18 days' mating, then it is believed that one ram per 100 ewes would be more than adequate, provided always that the flocks are run under conditions comparable with this county—namely, paddocks up to 35 acres, relatively flat and small mobs. These conditions probably include the great proportion of typical fat lamb country in New Zealand. In addition it appears likely that mating Romney ewes in this area later than 4 April will lead to increased lamb drop. Corriedale ewes should be joined on 20 March and later to achieve the same effect. Evidence is available that these dates do not vary greatly throughout New Zealand.

Reviewing the above evidence, it is more than probable that the cost structure of mating sheep under fat lamb conditions can be markedly reduced. The work appears likely to make a contribution to knowledge of the factors affecting sheep fertility in this country. In view of this, it is surprising that the project has received such little support at the national level, particularly at a time of falling prices, from the industries concerned.

In conclusion, acknowledgement must be made to the twenty-four farmers whose co-operation made the work possible, the

assistance of fellow veterinarians, the advice and assistance of research officers working in like fields and, last but not least, the Ashburton Veterinary Club who made the finance available.

DISCUSSION

Q:: *Were your "survey" rams selected from a number of stud flocks, and was special attention paid to the selection of the rams?*

A:: Although the rams under survey came from a great variety of studs, no attempt was made to compare the fertility of rams from different sources. Assuming that there are wide differences in fertility between rams, within a stud, it would be impossible to draw any conclusions regarding "between stud fertility" from the small representations of any studs involved in this survey. No special attention was paid to selection of the rams used, apart from palpation of testes and scrotum together with a semen examination, to reduce the risk of using infertile rams. As mentioned in the paper, of the forty rams used, we discarded one only, and I now believe that to have been unnecessary.

Q:: *Do you think the difference in climate between the North and South Islands is related to the differences in lambing percentage between these two islands?*

A:: It may be that differences in climate explain differences between North and South Island lambing percentages. There is no direct evidence indicating that this is true. We do know, however, that time of mating affects subsequent lambing percentage very markedly, and I am very strongly of the opinion that differences in time of joining ewes and rams are a major factor in explaining these differences between North and South Island. I would suggest to any sheep farmer with a low lambing percentage that he run a split flock trial. This would involve dividing the flock in half so that the age composition of each group was comparable and joining one half at the usual time and the other half during the first week in April where Romney ewes are involved, or about 20 March where Corriedale ewes are involved. If time of mating is involved in the low fertility, this will be clearly shown in the subsequent lamb crops. It can be mentioned, in passing, that one Hawke's Bay farmer who delayed his mating last year till 2 April—and that is heresy apparently in that part of the world—marked more than 100 per cent. of lambs for the first time in the history of the property. Alternatively, if you must have early lambs, use a ewe breed which breeds earlier than the Romney—and Corriedales are an example. Early mating—*i.e.*, early in March—can then be practised with less chance of impairing subsequent lambing percentages.

Q:: *Could you describe the physical condition of the "survey" rams after their mating period?*

A:: Visually, the physical condition of the survey rams at the end of 18 days' mating was considerably superior to rams run at the 2 per cent. rate. It was hoped, if the survey had been continued, to compare liveweights of survey and ordinary rams before and after 18 days' mating. Presumably the explanation of the better bodily condition of the survey rams lies in the absence of competition—when they are tupping they are tupping, and at other times they are feeding or resting.

Where more than one ram is run with a flock of ewes, each ram seems to be continually worrying about what the others are doing, and feeding time is accordingly reduced.

Q:: *Did you find any difference in the quality of the semen among the "survey" rams, and was that related to the subsequent average fertility of the ewes mated by them?*
A:: There were wide differences in semen quality between survey rams, but these differences did not appear to be related to differences in fertility of the rams. Semen examination is useful for picking very low fertility rams, but the criteria used are too crude to determine grades of fertility. There is a limited amount of evidence available that semen samples collected electrically from working rams—and I would stress working—is not the same as the semen the ram deposits in the ewe during the mating process.

Q:: *Was there any difference in average birth weight between lambs dropped in the first six-day period and those dropped in the last six-day period sired by the same ram?*
A:: No data were collected on this aspect. There is no reason to believe that there would be differences in birth weights of conceptions taking place during the first and last six days of the mating period. Birth weights are a function of the size of the dam and her nutritional status during pregnancy. There is a widespread belief that there is decreased viability or "strength" of offspring with increased sexual activity, particularly on the part of the male. This belief is quite erroneous.

Q:: *What factors influenced the decision to replace rams after 18 days?*
A:: This decision was taken in the interests of prudence before we had any idea of the capabilities of the rams. Five of the rams were not replaced and did the job apparently as efficiently as it would have taken the customary six rams with the size of the mob used. If the capabilities of the rams used in this survey are indicative of the capabilities of the average ram, it would appear that "hand mating" as practised in studs involves a great deal of work for very little return.

Q:: *Using the small number of rams as you did, was the lambing percentage comparable with the lambing percentage of the rest of the ewes on the farm?*
A:: Direct comparisons were not made, but the farmers involved were quite happy that there was no difference between the lambing percentage of these mobs and the rest of the flocks. There was evidence on some properties that there were fewer dry ewes involved with this system of mating. "The proof of the pudding is in the eating", and I know that the farmers who co-operated would have continued with the investigation if finance had been forthcoming.

Q:: *What is the usual mating procedure in Ashburton County?*
A:: Rams are put out at the rate of 2 per cent., although many farmers have used between 1 and 1¾ per cent. the last two years. Romney ewes are joined towards the end of March and during April. On the early country, where mainly Corriedales ewes are used, rams are joined from the end of February. Corriedale ewes breed effectively, earlier than Romneys. The rams are left out any time from 8 weeks till shearing or crutching.

Q:: *Has the time of shearing any effect on their subsequent fertility?*
A:: W. M. Webster, of Massey College, did work, a good many years ago, showing that carrying a heavy fleece could impair the ram's fertility. Shearing or heavy crutching of rams not later than 3 to 4 weeks before mating is widely practised today. The shearing of rams close to joining can temporarily upset the fertility of the ram.

Q:: *What steps did you take to prevent infertility of rams used in your trials?*
A:: Presumably the questioner means what steps did we take to prevent the use of infertile rams? The answer is, palpation of scrotum and testes for genital disease and semen examination.

Q:: *Could you comment on the practice of mating two-tooth rams with two-tooth ewes?*
A:: The mating of two-tooth rams with two-tooth ewes has been recommended as a means of assisting control of epididymitis in the ram and abortion in the ewe. Vaccination of rams is a much more effective method of achieving this. There is very strong evidence that shearling rams are less effective breeders than older rams, presumably owing to inexperience. In addition, two-tooth ewes are known to be shy breeders. I believe these considerations provide every reason for mating shearling rams with the older ewes, and older rams with the two-tooth ewes.

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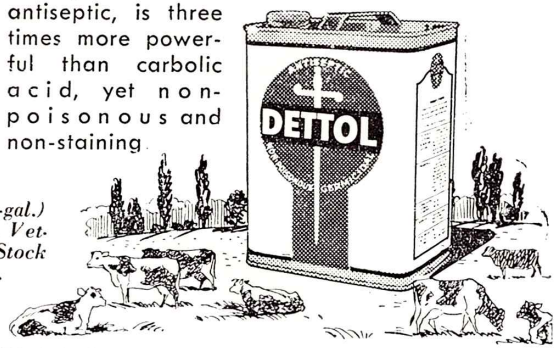

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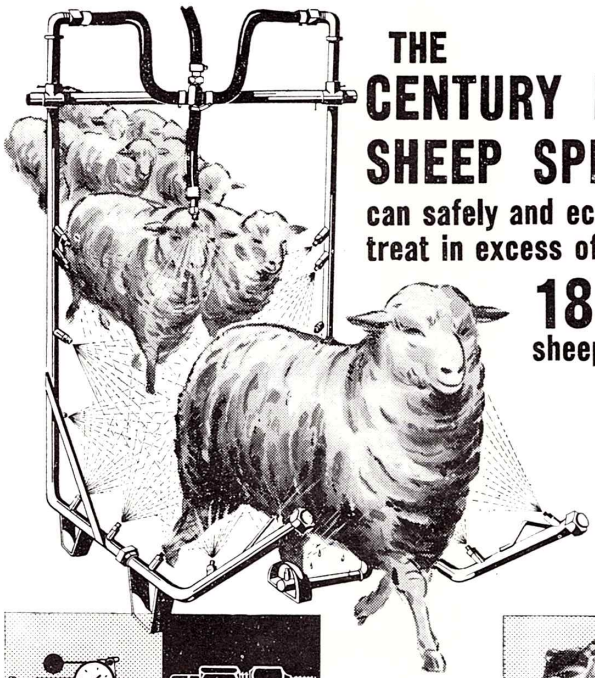

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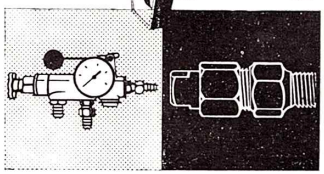

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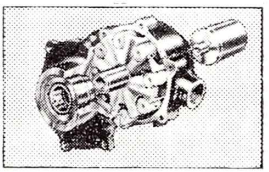

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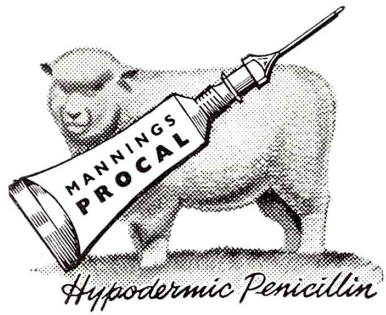

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SOME ASPECTS OF THE GISBORNE BEEF CATTLE FERTILITY SURVEY

E. D. FIELDEN* and D. McFARLANE†

A HIGH ANNUAL CALF CROP is basic in determining both the degree of selection that can be exercised in herds and the profits that can be derived from the saleable surpluses. To this end, the work at Gisborne has been mainly concerned with fertility of the breeding herd. As a large portion of the investigation has been concerned with pregnancy diagnosis in the autumn and early winter months, two preliminary comments about this technique are required.

First, in the hands of an experienced operator pregnancy diagnosis is an accurate method of identifying empty cows, provided, and this is most important, the bulls have been away from the herd for eight weeks prior to the examination being made.

Secondly, it is also possible to recognize late-calvers in the herd at the time of examination, a point which is not often appreciated. There are four very good reasons for doing just this:

(1) In herds where several grazing groups are run the late-calvers can be given harder treatment when feed supplies are limited.

(2) The number of late-calvers in a herd may often indicate the presence of a breeding problem.

(3) When over-mating is carried out the late-calvers can be the first of the pregnant cows sold, if pregnant cattle are to be sold.

(4) If suitably identified the performance of these cattle can be followed. This seems highly desirable, as little is known about the efficiency of late-calvers in Gisborne herds and they may well be a very suspect group.

The actual extent of the infertility problem in beef cattle must await the carrying out of a properly designed survey. It is believed that methods of doing this are now available. Some of the questions which might be asked in such a survey will be obvious from a consideration of the figures and tables. These, while in no way defining the extent of the problem in Poverty Bay, at least give some indication of its nature.

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†Gisborne Veterinary Club, Gladstone Road, Gisborne.

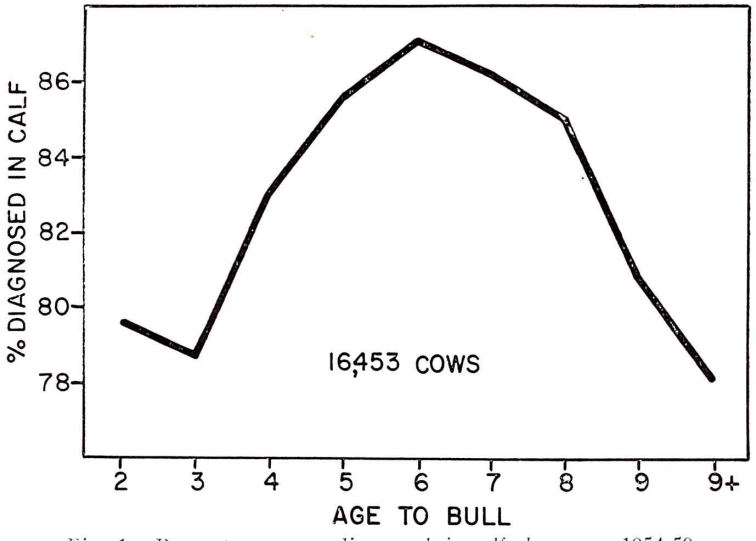


Fig. 1: Percentage cows diagnosed in-calf, by ages, 1954-59.

Figure 1 shows the in-calf performance of some 16,000 cattle by ages over the last 6 years. This material was all obtained from pregnancy diagnosis data collected during the autumn and early winter months. The in-calf percentage is defined as being:

$$\frac{\text{Number of cows diagnosed in-calf} \times 100}{\text{Number of cows mated}}$$

It will be seen from Fig. 1 that, except for the 3-year-olds, the efficiency of getting cows in-calf increases as they mature, and there is no substantial fall off in performance again until after the 8th year of age. Note the relatively poor performance of the three-year-old cattle. The proportions of late-calvers in these various age groups have been measured and it was found that 2-, 3-, and 4-year-olds had 14 per cent. of late-calvers, while the 5-, 6-, 7-, and 8-year-olds had only 11 per cent. of late-calvers. A late-calver is defined as a cow which has failed to hold in-calf during the first two months that the bulls are out. The number of late-calvers has been expressed as a percentage of the cows actually in-calf at the time of pregnancy examination.

Figure 2 involves data collected where whole herds have been examined during the last three years. The general trend is again similar for both poorer and better producing herds, but the degree of fluctuation is much greater in the poorer herds, and the efficiency of the three-year-olds in them is particularly poor.

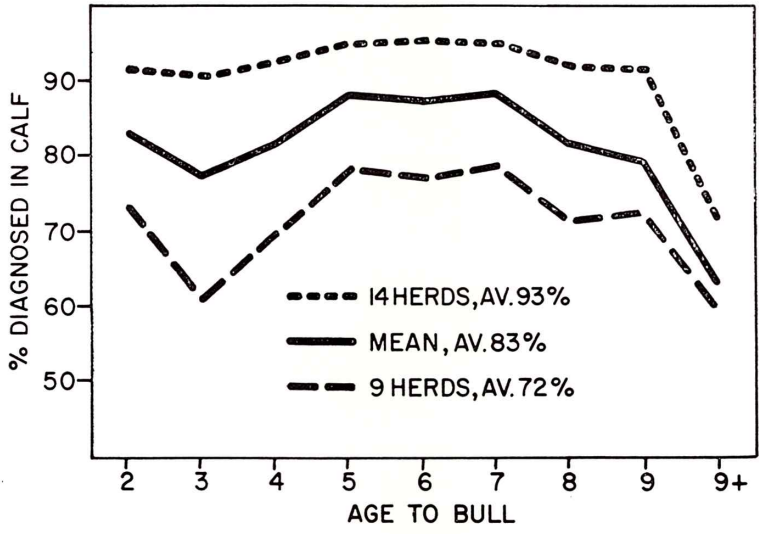


Fig. 2: Percentage cows diagnosed in-calf, by ages, 1957-59.

Figure 3 indicates the average age composition of 23 herds in the Gisborne area and the in-calf percentages by age groups. The very important part the young stock play in determining the actual calf crop becomes obvious from an inspection of the top half of this figure.

What has been discussed so far has been concerned with the in-calf percentage. What about the number of calves actually marked? This is obviously of much greater interest. This figure is defined as the effective calving percentage and it is:

$$\frac{\text{Number of calves marked} \times 100}{\text{Number of cows mated}}$$

In most cases it will be very close to the number of calves weaned. The difference between the in-calf percentage and the effective calving percentage on 23 properties examined was about 7 per cent. with a range between properties of 0 to 12 per cent. The reasons for these differences are many and varied and Table 1 indicates at least some of the possible causes:

Referring back for a moment to Fig. 2 and using the average loss figure of 7 per cent., it is seen that the poorer herds would have had on average an estimated effective calving of 65 per cent.

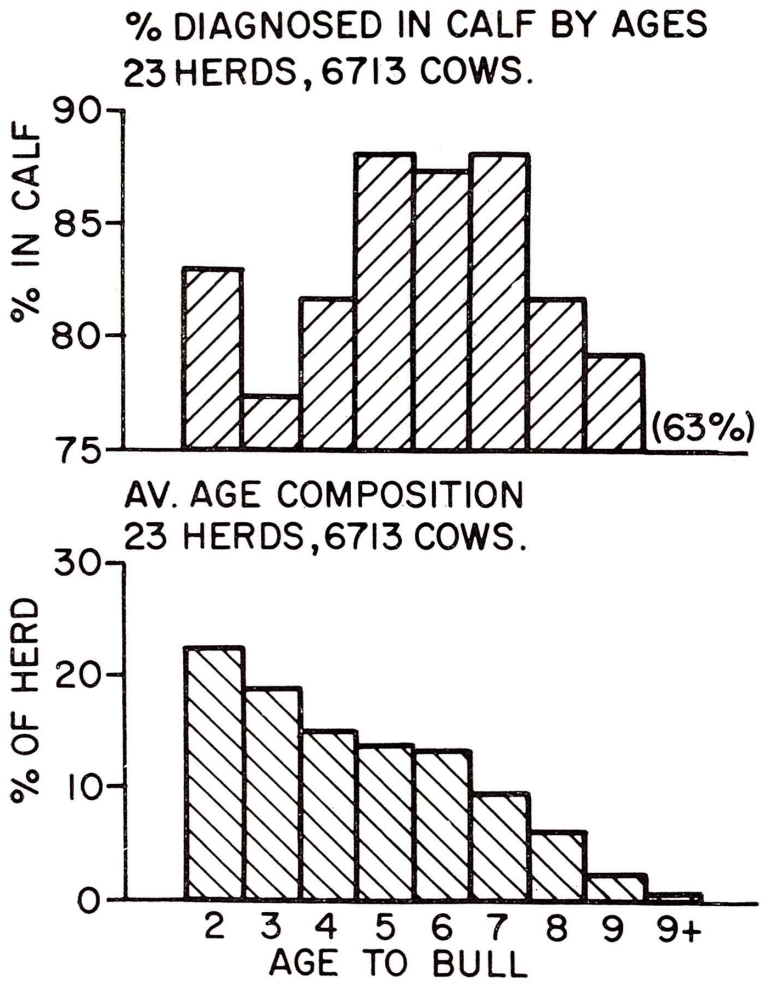


Fig. 3: Percentage cows diagnosed in-calf, by ages—23 herds, 6,713 cows.

while the better herds would have been about 86 per cent. The poorest herd performance was just under 50 per cent. and the best just over 90 per cent. in terms of calves marked.

That a variation in calving percentage should exist from property to property or even within the one property from year to year will be nothing new to stock owners; the question, of course, is whether the reasons for such variations can be found, and having been found what can be done about controlling them?

TABLE 1: Reasons for Differences between In-calf and Effective Calving Percentages.

$$\text{In-calf percentage} = \frac{\text{Cows diagnosed in-calf} \times 100}{\text{Cows to bull}}$$

Average loss 7 per cent. of calves from cows diagnosed in-calf.	1	Early abortions, early foetal death (trichomoniasis, vibriosis, unknown)
	2	Late abortion, calves born dead (brucellosis, leptospirosis, mycotic abortion, difficult calving, unknown)
	3	Deaths from birth to calf marking (miscellaneous causes such as under-runners, no milk, etc.)
↓	4*	Cow deaths.

$$\text{Effective calving percentage} = \frac{\text{Number of calves marked} \times 100}{\text{Cows to bull}}$$

*Although cow deaths will affect the effective calving percentage they have been allowed for and are not included in the average loss figure of 7 per cent. As a general recommendation, if discrepancies of the order of 10 per cent. or more exist in the herd, then the situation should be critically examined.

What, then, are some of the more obvious factors affecting hill country calving percentages? These are most conveniently discussed under three headings: management, breeding, and disease control.

Management

FEEDING

Reduced food intake has been shown to delay sexual maturity and inhibit oestrus in all mammalian species studied. Crude methods of wintering the breeding herd and inadequate supplies of food for young growing stock, together with the demands of early lactation, may impose sufficient stress on animals to result in impaired fertility in the subsequent breeding season. Feeding for efficient reproduction demands that heifers should be well grown for mating at least by the age of two years and that these same heifers be given a high level of feeding both when they drop their first calves and throughout their subsequent lactation.

Phosphorus, protein and vitamin A are other specific food factors which may affect the reproductive capacity of the cow.

Whether such deficiencies occur under hill country conditions in this country is not known.

Size at First Mating

United States data suggest that a heifer should reach 650 lb liveweight at 20 months to give her best performance.

Figure 4 shows the result of a trial with two-year-old Aberdeen Angus heifers on one of the East Coast properties near Gisborne. Their body weights were assessed from chest girth measurements the day they were put out with the bulls. The performance of these heifers as far as getting in-calf was concerned is clearly shown in Fig. 4, the implication being, of course, that heifers should be well grown at the time of mating. It is suggested that this type of investigation might be fruitfully expanded.

Age When First Mated

Heifers should be reared sufficiently well to be mated successfully by two years of age on most hill country. Except in exceptional circumstances mating at 3 years of age is unwise, for,

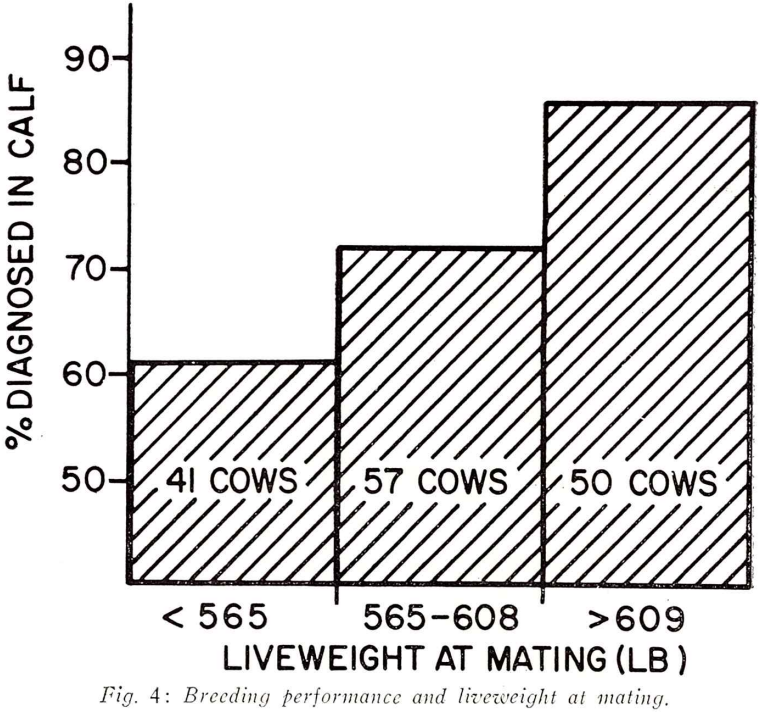


Fig. 4: Breeding performance and liveweight at mating.

TABLE 2: Age at Mating (200-cow herd; 20 per cent. two years old).

Age to bull	*Number Mated*	*Calving percentage*	*Calf crop*
3	160	90	144
2	200	75	150

although the effective calving percentage may be higher, the overall calf crop may well be lower than when mating at 2 years, as is seen in Table 2.

AGE AT CULLING

There seems little point in culling before the age of nine years; at this stage cows have only just passed the peak of their efficiency.

MATING PRACTICE

(1) United States work indicates that one-bull mating mobs achieve 6 per cent. higher calf crops than multiple-bull mobs. If one-bull mobs can be used, it is desirable to switch bulls at least every three weeks to counteract the effect of possible sub-fertile sires.

(2) The cow-to-bull ratio under extensive mating conditions could stand much closer examination. Where one bull may effectively cover 50 cows in a relatively confined area, his ability to do the same thing under extensive conditions is questionable. This type of problem can be solved on a property by planned mating trials.

(3) From American beef cattle studies it was found that higher calf crops were obtained by using bulls up to and including 5 years of age than by using bulls over that age.

(4) It seems almost unnecessary to stress that bulls should be in good health and condition when they are turned out with the herd; particular attention should be paid to the condition of the feet. The writers are not prepared, at this stage, to recommend the widespread use of semen obtained for examination by the electro-ejaculation method prior to the mating season as the techniques and understanding of its limitations are, at present, not sufficiently understood to make it a reliable method of assessing male fertility.

Breeding

The only comment is in regard to cross-breeding. The more one sees and reads of the first cross animal, the more impressed one becomes in regard to such important production features as

lower losses, faster growth, larger size, and higher calf crops. Planned cross-breeding (envisaged here is the triple cross or three-breed system) does involve management problems certainly, but the results appear so promising that it is believed such a system might be more critically examined by breeders in the industry.

Disease Control

The five infectious diseases which directly affect calving percentages have already been mentioned. An investigation to determine how important a part they play in the herd problem has been started in the Gisborne area, but is still in its infancy. Preliminary results would indicate that many of the problems cannot be explained in terms of known disease. This situation, of course, is already known in certain areas in the dairy industry. The answer to this question would be a most valuable step in determining the course of further fertility studies.

Brucellosis

Commonly known as "contagious abortion" this disease may cause widespread losses in unvaccinated stock, and it is probably still the most important infectious disease affecting calving percentage in herds. R. Crawford, in 1949, estimated an increase in effective calving of 8.5 per cent. when widespread vaccination of beef cattle was commenced in Poverty Bay. The results of extensive surveys by the New Zealand Dairy Board in the dairy industry have also supported the value of Strain 19 vaccination in both reducing infertility and preventing abortion. Vaccination with Strain 19 is a must, and all potential breeding heifers should be vaccinated, preferably between 8 and 12 months of age, or at least three months before being put with the bull.

Leptospirosis

This is another disease which may cause abortion outbreaks, usually in mid- or late-pregnancy; it does not appear to be very common, but when occurring losses may be severe. A vaccine is available for protection against this disease that appears to have given satisfactory results clinically.

Trichomoniasis

This is a venereal disease transmitted by the infected bull and has been confirmed only once to the writer's knowledge in the Poverty Bay area. Control is difficult under run cattle conditions, but can be achieved by disposal of bulls, sexual rest of the females

for at least three months, and the elimination from the herds of any cows that show evidence of foetal mummification or pyometra (pus in the uterus).

VIBRIOSIS

This is another venereal disease which is not completely understood and which may be fairly widespread in beef herds. Classically, it causes early foetal death, and results in cows either not being in-calf or being late-calvers. Abortion about mid-pregnancy does occasionally occur. Unfortunately, control is exceedingly difficult under run conditions, and at present is probably best attempted by the use of a two-herd system in which virgin heifers and virgin bulls are run together as a separate unit. The importance of vibriosis in beef herds badly needs assessing and the development of an effective vaccine could be of very great value.

MYCOTIC OR FUNGAL ABORTION

Certain species of fungi do cause abortion, and such cases have been recorded in New Zealand. As yet they do not appear to constitute a serious problem.

The practice of over-mating in relation to the calving percentage has not been discussed. The omission has been deliberate because over-mating by itself contributes little, as far as is known, to the effective calving percentage of the herd. It does, however, contribute much to the actual calf crop obtained and is to be commended as a system of achieving this end. In brief, all this system entails is the mating of more breeding stock than it is intended to winter, and the subsequent elimination of dry cattle, and surplus pregnant cows by pregnancy diagnosis in the autumn.

Finally, because of the very varied nature of the farming environment, and because of the very important part this environment plays in the fertility of stock, it would be presumptuous to pretend all the requirements necessary to achieve high calving percentages in cattle are known. Nevertheless, with the limited knowledge already obtained there is no reason why New Zealand beef herds should not play their full part in the national economy and still be capable of rearing 85 per cent. of calves regularly and 90 per cent. often.

Acknowledgements

The writers wish to thank the New Zealand Wool Board, the New Zealand Meat Board, and Veterinary Services Council for providing funds for the development of this work, and they offer

their appreciation to all those farmers and veterinarians who have become interested and co-operated with them in the field studies involved.

DISCUSSION

Q:: *Are calves from heifers first mated at three years of age better than those from heifers mated at two years of age?*

A:: We have no data or observations on this point. It would be surprising if heifers mated at three years did not give birth to heavier calves than those mated at two years of age but whether they would rear them any better or not is something we have not measured.

MR BUCHANAN:: It used to be the practice with Herefords to mate first at three years old and their calves were as good as those from mature cows.

Q:: *Was the subsequent performance of the twice-dry three-year-olds followed up?*

A:: No, it is routine practice in the area to cull twice-dry cows. Many farmers cull cows for one breeding failure.

Q:: *Would the speaker enlarge on the efficiency of bulls over five years of age?*

A:: The comment referred to in the paper is based on American work and no similar trials have been carried out in this country to our knowledge. Obviously many bulls over the age of five years will still be effective and the New Zealand Dairy Board found with dairy bulls under natural service that their fertility did not appear to decline until the eighth or ninth year. It must be remembered, however, that dairy bulls do not have to scale round the hills like their beef counterparts. The American work can be accepted as a guide but culling a bull on age alone would be unwise unless you were forced into mating him to his own daughters.

Q:: *Surely the breeding performance of a bull depends more on his physical condition than his age?*

A:: Obviously physical defects such as lameness in the hind feet will impair a bull's ability to serve but whether it is possible to judge breeding performance on bodily condition is another matter. Bulls in poor condition appear to produce smaller quantities of semen than those in good condition but this does not necessarily mean that their fertility or their capacity will be seriously impaired.

Q:: *In what size of herd did you get 90 per cent. calving?*

A:: The figure refers to an in-calf performance of a 900-cow Aberdeen Angus herd which commences mating at three years of age. This herd is used extensively in fern control. There are several other herds ranging in size from 80 to 200 breeding cows giving a similar performance in the Poverty Bay area; these latter herds mate at two years of age.

Q:: *Is there any difference in calving percentage between different breeds or crosses?*

A:: In our limited experience with crossbred animals (and this refers to the first cross only) in the area their performance has been exceptionally

good. American data certainly support this observation that the crossbred has produced more calves than at least one of the parent breeds with which it was compared. We have far too little information to make between-breed comparisons in this country. The difference, if any, between the two main beef breeds is probably quite small.

MR BEAMISH: My experience over the last twelve years results in the crossbreds giving a slightly lower calving percentage than the pure Herefords.

Q: *What was the ratio of Aberdeen Angus to Hereford in the 16,000-odd cows in the table?*

A: Approximately equal numbers of each.

Q: *Is there any advantage in mating at two years old and then running these cows through, dry, the following year after their first calf?*

A: This has not been tried. The point is, of course, that immediately this is done the overhead per calf produced (which is already high) is further increased. Efficient production demands a calf every year and commencing at as early an age as is compatible with the health of mother and young. If your first calvers are so poor that they do not get in-calf their second season, then you should take a very good look at the feeding situation amongst other things.

Q: *If mating is delayed until three years of age is the breeding life of the cow extended?*

A: We do not know.

Q: *How do you detect the presence of* Vibrio fetus *in a herd?*

A: There are several tests which can be made by a veterinarian. Direct examination of an aborted foetus or the discharge from an aborted cow by a diagnostic laboratory is one method. Indirect tests by a laboratory on vaginal mucus is another method. A large percentage of empty cows or a large number of late-calvers at the time of pregnancy diagnosis should always be looked into and one test that should almost certainly be made would be for the presence or absence of vibriosis as a possible cause of the problem.

Q: *Would the speaker consider it advisable to vaccinate the cows against contagious abortion after the bull has been run with the cows?*

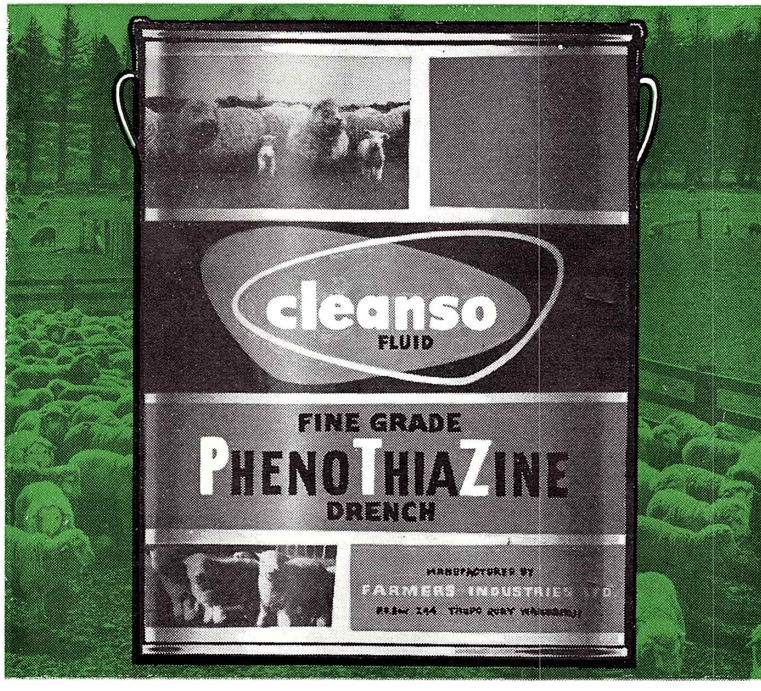
A: This can and has been done with safety in many cases but at the present state of knowledge it is not the method of choice. The reasons for suggesting that they be done before sexual maturity and especially before first pregnancy are threefold:

(1) Sexually mature stock, if exposed to natural infection, are likely to remain infected whereas sexually immature stock, as far as is known, are not. Vaccination prevents, it does not cure.

(2) At later ages before vaccination the more opportunity the cow has to become infected before vaccination takes place.

(3) Work at Compton in the United Kingdom indicates that a single vaccination at six months of age gives adequate protection for at least five pregnancies and probably for the lifetime of the cow.

LOOK FOR THE NEW TIN - LOOK FOR THE NEW TIN



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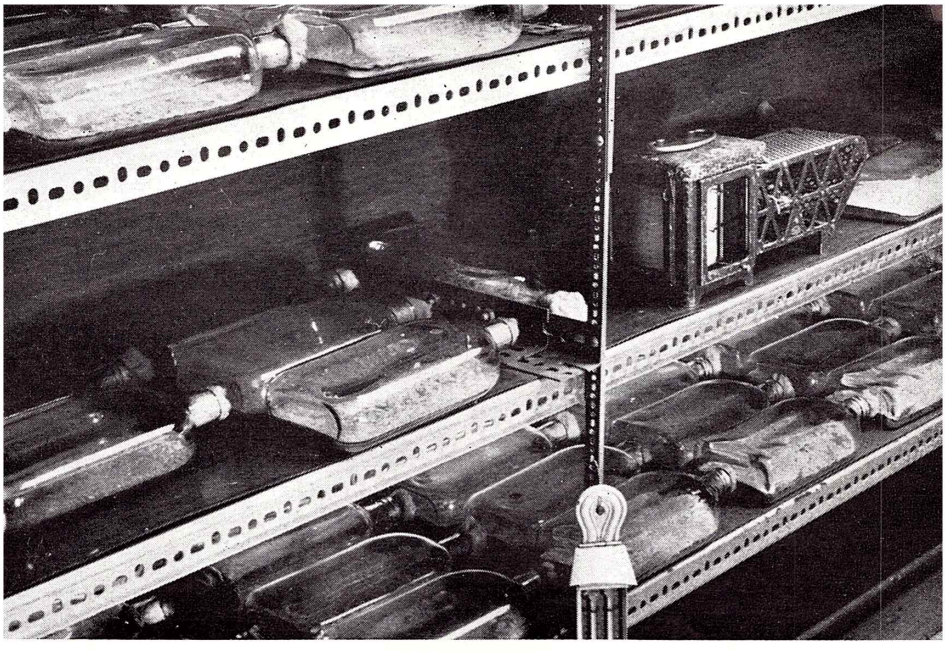

Fermentation room, showing growing of fungus in Roux bottles.
(Dept. of Agriculture photo.)

FACIAL ECZEMA RESEARCH
In the Department of Agriculture

J. F. FILMER*

On previous occasions when I have addressed farmers' meetings on the subject of facial eczema, I have described the investigations into the disease, outlined the results that have been obtained, and recommended control measures based on these results. Dr A. T. Johns and I will describe some more recent investigations, with special reference to the discovery of the fungus; we will outline some new results; but I, at any rate, will make no new recommendations about control measures.

To avoid any misunderstanding, let me say that I had nothing to do with the discovery of the fungus. Moreover, I think I was probably the only person in New Zealand who did not anticipate its discovery.

THE IDEA THAT A FUNGUS might be the cause of facial eczema is, of course, not new. It was commonly mooted during the serious outbreaks of 1938 because of the abundance of mushrooms and other fungi in affected paddocks. A survey of fungi was made at

**Department of Agriculture, Wellington.*

that time and tests were conducted with some of those found. The negative results obtained prompted the hypothesis that the liver-damaging factor was formed in one or more pasture species following warm autumn rains. In 1941, liver damage was produced in experimental lambs fed freshly cut pasture, and in 1943 similar results were obtained with heat dried pasture.

Intensive chemical investigations have shown that the liver-damaging factor could be extracted from affected pasture. After being concentrated and purified until they contain as little as $\frac{1}{70000}$ of the original dry matter, the extracts are still capable of producing liver damage in guinea pigs and other experimental animals. In the course of this work, a chemical test was devised known as the "beaker test", which is capable of estimating the concentration of the liver-damaging factor with reasonable accuracy.

This line of attack diverted attention from the fungus hypothesis, though it was revived from time to time by some workers. In February, 1957, an active search for fungi or other organisms in soil and pasture was commenced by officers of the Soil Bureau working in collaboration with officers of the Department of Agriculture, and this led to the dramatic discovery in March, 1958, that spores of *Sporidesmium bakeri* gave a strong beaker test. It was soon shown that a high-sporing strain of this fungus caused typical liver damage in guinea pigs and lambs and produced all the usual symptoms of facial eczema in one experimental lamb. This exciting story has been told elsewhere,* and it is not proposed to repeat it here.

Instead, some of the implications of the discovery of the fungus will be discussed. This discussion will be introduced by posing certain questions and such partial answers as are at present available will be given. The questions are:

(1) Is the liver-damaging factor in the fungus the same as that in pasture?

(2) Is the fungus the cause of facial eczema in the field?

(3) What factors influence the abundance and toxicity of the fungus?

(4) How can the fungus be controlled?

(5) How does the liver react to the fungus?

(6) Can stock be protected against the fungus?

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*N.Z. *Journal of Agriculture*, 97: 328 (1958).

Before these questions can be answered completely, it will be necessary to learn a great deal more about the fungus itself—*e.g.*, research workers must find out how to grow the fungus in quantity; whether the method of growth affects its toxicity; whether spores are the only, or the most, toxic part; and how to measure the abundance and toxicity of the fungus in the field. Partial answers to these questions have been obtained, and Dr A. T. Johns will be dealing with some of them (see page 47). In this paper it is proposed to discuss each of the questions in turn.

Is the Liver-damaging Factor in the Fungus the Same as that in Pasture?

Obviously, the complete answer to this question must await the isolation and identification of the liver-damaging factor from both pasture and fungus. However, investigations at Ruakura and Wallaceville have failed to show any difference in the chemical and pathogenic qualities of the extracts containing the liver-damaging factor from the two sources.

The concentration of the liver-damaging factor in some cultures of the fungus is very much greater than in the most toxic samples of pasture. This has facilitated the work of the chemists and should result in the isolation of the liver-damaging factor sooner than seemed possible when it had to be sought in pasture.

Is the Fungus the Cause of Facial Eczema in the Field?

Again the evidence is incomplete. However, it can be stated that the fungus has always been found when sought for on pasture which has produced liver damage. At Manutuke during 1959, it was possible to compare liver damage in grazing lambs with spore counts and beaker tests on the pasture grazed by them. There was a very good general relationship among these three measures of toxicity.

Thus, while it is not yet possible to say that facial eczema never occurs in the absence of fungus, all the available evidence supports the idea that fungus does cause facial eczema in the field.

What Factors Influence the Abundance of the Fungus?

Much of the work on the effect of weather, pasture species, and litter has been done by branches of D.S.I.R., and Dr Johns will indicate how these factors affect the abundance of the fungus.

At Manutuke, two paddocks were mowed regularly from October, 1958, onwards at intervals of one to three weeks according to the growth taking place. The pasture was never allowed to become more than 2 in. high. All the clippings were left on one paddock and those collected in a catcher were removed from the other. Another paddock was severely harrowed at weekly intervals from late January to mid-March. From early January, pasture samples were collected at weekly intervals from these and other paddocks and sent to the Soil Bureau, Taita, where spore counts were made. These were much higher on mowed and harrowed paddocks than on untreated paddocks. Severe liver damage occurred in nearly all the lambs grazing the mowed paddocks during January and February, and 35 per cent. of them developed skin lesions. Severe liver damage and skin lesions also occurred following harrowing. Mowing and harrowing both caused a rise in beaker tests. It is presumed that both treatments increased the abundance of the fungus by providing litter on which it could grow.

How Can the Fungus be Controlled?

Reports that facial eczema had been prevented by topdressing with copper and cobalt led to the testing of this treatment at Manutuke in the autumn of 1957. Five one-acre paddocks carrying a similar sward were topdressed as follows: no topdressing; 2 cwt superphosphate; 2 cwt superphosphate + 5 lb copper sulphate; 2 cwt superphosphate + 5 oz cobalt sulphate; 2 cwt superphosphate + 5 lb copper sulphate + 5 oz cobalt sulphate. Topdressings were applied on 11 January and each paddock was set-stocked with 12 lambs from 14 January to 14 May, when all lambs were killed and their livers examined. The results of these examinations are given in Table 1.

Table 1: Effect of Topdressing as Judged by Liver Damage

Treatment	*Liver Damage*		
	None	*Slight*	*Severe*
No topdressing	4	7	1
Superphosphate only	2	7	2
Superphosphate + copper	2	8	1
Superphosphate + cobalt	2	9	1
Superphosphate + copper + cobalt	3	7	2

It is thus obvious that topdressing with safe amounts of copper and cobalt cannot be relied on to prevent facial eczema. There is a good deal of field evidence to support this conclusion.

In the following year, topdressing with a total of 27 lb copper sulphate per acre was tested in an effort to confirm the results of an experiment reported on by Dr Johns. No liver damage occurred in lambs grazing either the treated or untreated paddocks. The copper concentration in the liver of all the lambs grazing the treated paddock reached a dangerously high level.

In 1959, tests were made at Manutuke with three different fungicides which had proved toxic to the fungus in the laboratory. All appeared to be without effect in the paddock, even when applied repeatedly. The use of fungicides is beset by many difficulties. To be effective, the time of application may have to be calculated very accurately and they may need to be applied at short intervals. Most fungicides are quite toxic. One-tenth of an ounce of one of those used killed a lamb in less than 24 hours. A total of 7 lb per acre of this fungicide in three applications was ineffective in controlling the fungus. Enough fungicide to kill more than 1,000 lambs was applied per acre over a period of two months.

A culture of a soil organism, *Bacillus subtilis,* which had prevented the growth of the fungus in culture was also ineffective in the paddock, as was topdressing with ½ ton of slaked lime per acre and 6 cwt of superphosphate per acre.

At present there is no safe method which can be recommended for controlling the fungus nor is it easy to visualize any way in which it could be controlled. However, it is being studied intensively in both the laboratory and the field and this should result in a better understanding of the conditions which favour or hinder its growth. Such an improved understanding may indicate a method of control.

How Does the Liver React to the Fungus?

For many years the changes in the liver have been studied in natural and experimental cases of facial eczema in sheep, cattle, and guinea pigs. Until the discovery of the fungus, it was not possible to give graduated doses of the liver-damaging factor to large groups of animals and kill them at short intervals to discover just how the liver reacted. Now that large quantities of fungus cultures are available, such experiments can be undertaken.

Already one experiment, involving more than 200 guinea pigs, has been conducted, and similar experiments with mice, rats, rabbits, and lambs have been started or are planned. Culture material, or extracts of it, are being given both by mouth and by injection into different sites, including the gall bladder and the vein leading to the liver.

These experiments are very important. Until the effect of a known dose of liver-damaging factor on experimental animals can be accurately measured, it will not be possible to calculate the effect of measures designed to protect these animals.

In addition to experiments with animals, the effect on cultures of living cells is being studied. If successful, this method would enable the toxicity of an extract to be measured quickly using only very small quantities.

Can Stock be Protected Against the Fungus?

Two avenues are being explored—antidotes and vaccines. Antidotal treatment probably has little hope of success as a practical measure. An antidote must usually be given before, with, or immediately after the poison, and with grazing animals this presents obvious difficulties. The discovery of a successful antidote would, however, be of considerable value in aiding an understanding of the disease. Since the discovery of the fungus, vaccination has become a real possibility, as some fungi are known to provoke the formation of antibodies. This question will be thoroughly explored, as vaccination would be a very practical way of controlling the disease.

In conclusion, it can be stated that, though no new way of controlling the disease has yet been found, the discovery of the fungus has opened up many new lines of attack, and one or more of these may well prove fruitful.

In the meantime, farmers are recommended to use the control measures which, in spite of their disadvantages, have been successful in preventing any outbreak of facial eczema at Ruakura during the past sixteen years.

[*For Discussion, see p.* 57]

Petrie dish culture of fungus growing on potato-carrot agar.
(Dept. of Agriculture photo.)

FACIAL ECZEMA RESEARCH
In the Department of Scientific and Industrial Research

A. T. JOHNS*

A VERY SEVERE OUTBREAK of facial eczema in 1938 caused heavy stock losses over a large proportion of the more fertile land of the North Island. Investigations of the causes of the outbreak were believed to have eliminated the possibility of a micro-organism as the culprit, and it was considered that by far the most probable cause was a toxin in the pasture herbage induced by abnormal growth conditions. This was believed to be just one

*Plant Chemistry Laboratory, D.S.I.R., Palmerston North.

more link in the chain of observations that rapidly growing pasture plants can cause serious disorders of livestock. It was considered that facial eczema was in the same category as bloat and staggers in being associated with abnormal pasture growth conditions.

The Plant Chemistry Laboratory, D.S.I.R., was established in 1938 under Dr J. Melville to study the relationship of problems such as these to the biochemical processes of pasture plants, with special reference to facial eczema. Regular meetings of facial eczema workers from both the Department of Agriculture and the D.S.I.R. were held for several years, but, as Dr Melville left the Plant Chemistry Laboratory for war service, and the laboratory was diverted to defence priority work, D.S.I.R.'s participation gradually decreased and ceased altogether in 1945. The Department of Agriculture continued the work at their Wellington Chemical Laboratory and later at Ruakura. The investigations were, however, hampered by the lack of a supply of toxic grass and a suitable assay procedure for the toxin.

Large-scale Extraction of Toxic Grass

In 1957, a large amount of facial eczema toxic grass was collected at Manutuke and other Poverty Bay farms. Dr J. F. Filmer offered the D.S.I.R. 5 cwt of dried grass so that they could again participate in the facial eczema research programme. Dr E. P. White at Ruakura had by this time reached the stage where it was possible to produce, as a routine small-scale procedure, a concentrate containing $\frac{1}{20000}$ of the original weight of grass. After consultation with the Ruakura workers, it was decided that, rather than work independently, the Plant Chemistry Division could best help the programme on the isolation of the toxin from grass by putting White's procedure on a large scale.

Some of the procedures that were used in the laboratory could not be scaled up to handle large quantities of materials. Over a period of several months, modifications were made and checked by guinea pig testing. Finally, a large-scale process was developed that was at least as good as White's original procedure to the $\frac{1}{3000}$ stage and capable of handling 40 lb batches of grass.

The discovery in 1958 that facial eczema could be caused by a fungus changed the picture radically in that the chemists were no longer dependent on grass collected in the field as a source of starting material. However, some 450 lb of grass was processed

to provide enough material so that, when the toxic substance is finally purified from the fungus, its identity with the material isolated from toxic grass can be established.

Discovery of a Fungus as a Cause of Facial Eczema

The events leading to the discovery of the fungus were the result of several years' intensive work by Dr R. H. Thornton and his team at Soil Bureau, D.S.I.R., Taita.

The microbiology team at Soil Bureau set out to gain a broad picture of the soil micro-organisms in New Zealand. Two projects were drawn up, first to study micro-organisms under tussock grassland and the exotic pasture that is replacing it, and, secondly, to study the micro-organisms under forest and the exotic pasture in the same way.

By the end of 1956, the first project had been completed and Thornton and co-workers began to think seriously of the micro-organisms associated with grass roots and, because of observed marked seasonal peaks in microbe numbers, resurrected the theory that soil microbiology might play a part in the facial eczema problem.

As a result of discussions with Dr Filmer and Dr C. P. McMeekan, it was decided in 1957 to include some of the facial eczema areas in the microbiological examinations. Hence samples were examined from Claudelands showgrounds in Hamilton, Judgeford, Marton, and Palmerston North. As the samples were collected, it was the task of the microbiological team to identify the many species present and to select those organisms which showed a significant increase in population prior to, or at the time of, the production of toxic grass. These selected organisms were grown on various media and given a preliminary screening for toxin (a) by the beaker test at Ruakura and (b) by feeding to guinea pigs at Taita. Some 4,500 isolates (80 species) were made from the soil and grown in culture, and some 1,500 were cultured from pasture leaves. Approximately 1,000 soil isolates were cultured from Claudelands alone.

Among the first micro-organisms that attracted attention was a new species of red yeast, *Rhodotorula graminis*. It reached its peak of numbers on the dry pasture just prior to the first autumn rains and in some samples comprised up to 1 per cent. of the weight of pasture (100 million per gram of pasture). This organism produced large amounts of fat. Three preliminary guinea pig feeding trials all gave negative results.

Meanwhile, in May, 1957, Dr K. J. Mitchell, following claims by certain farmers that copper sulphate topdressing prevented facial eczema, reported results of a small experiment with lambs on plots which had been topdressed with a mixture including 30 lb per acre of copper sulphate. Although a dangerously high copper level was reached in the lambs, the results tended to confirm the farmers' claims. Owing to the well-known fungicidal properties of copper sulphate, this experiment gave renewed hope to the Taita team, who, at this stage, were considered to be following a very long shot.

In March, 1958, J. C. Percival observed mycelia on the Claudelands plot and sent Dr Thornton samples which contained the mycelia of several fungi. Of these, *Stemphylium botryosum* was the most common.

A few days later, Percival collected from the blades of a mower a sample of spores which were present in large numbers on the Claudelands plots, and, realizing its possible significance, had it checked for beaker test. The result was positive. The spores were identified by Dr Thornton as those of *Stemphylium botryosum*, later renamed *Sporidesmium bakeri*. It was therefore tempting to speculate that, since the spores of *Sporidesmium* had reacted to the beaker test, the same organism might also at some stage of its growth produce the toxin.

In May 1958, in order to check the reaction of *Sporidesmium* and other fungi to the beaker test, *Sporidesmium* was grown on sterilized non-toxic grass, on dead ryegrass roots, and on nutrient solution. Together with six other fungi, these samples were sent to Ruakura for beaker test. All were negative, as were the feeding tests to guinea pigs at Wallaceville.

At this stage, Dr Thornton examined samples of toxic and non-toxic grass sent by Dr G. W. Butler from the trial area at Massey College. Large numbers of *Sporidesmium* spores were present on the toxic grass samples, whereas on non-toxic grass the numbers were considerably fewer. Dr Thornton therefore went on with trials of these organisms, and, because of the large numbers of spores present on grass samples, selected a high-sporing strain. At last one positive beaker test was obtained from Strain C, grown on potato-carrot media.

Dr Thornton's cultures of *Sporidesmium bakeri* Strain C grown on potato-carrot media at Taita and Ruakura were fed to guinea pigs at Ruakura. The results were positive. Liver damage typical

of facial eczema was later produced in a lamb fed on the fungal material. It was now clear that the micro-organism, *Sporidesmium bakeri*, could produce the disease known as facial eczema.

This discovery did not, of course, mark the end of the research programme. It marked the beginning of a more intensive programme involving a large number of workers in all the various phases that needed to be studied.

Current Work in D.S.I.R.

The Divisions of D.S.I.R. now engaged in research into facial eczema include:

(1) Plant Diseases Division, Auckland;
(2) Soil Bureau, Taita;
(3) Grasslands Division, Palmerston North;
(4) Plant Chemistry Division, Palmerston North;
(5) Dominion Laboratory, Wellington;
(6) Fats Research Laboratory, Wellington.

where some 16 professional officers have been concerned with various aspects of the work over the past year.

Plant Diseases Division and Soil Bureau

These two institutions are mainly concerned with a study of the fungus itself—*i.e.*, its taxonomy, what it grows on in the field, the optimum conditions for its growth in culture and for maximum spore production, whether toxin production varies with strain and conditions of growth, and how best to grow it on a large scale to produce extracts for the chemists to work.

Techniques for sampling paddocks to indicate how much fungus is present have been developed at both institutions.

Sporidesmium bakeri was first reported from banana leaves from the Philippines in 1914. It has since been reported from the tropics as occurring on rice, maize, sorghum, pigeon peas, and palm leaves. The fungus is a saprophyte which appears to be able to grow on just about any dead plant material.

Miss J. M. Dingley, in her search for strains in New Zealand, has noted the following host plants on which colonies of this fungus have been found: Yorkshire fog, ryegrass, cocksfoot, tall fescue, prairie grass, browntop, paspalum, both red and white clover, *Lotus* species, plantain, dock stalks, fennel stems, and damaged potato leaves.

Field studies by Dr P. J. Brook confirm the findings that *S. bakeri* colonizes dead material of practically all herbaceous plants found in pastures. A combination of relatively high temperatures and humid conditions and the presence in abundance of dead plant material provides optimum conditions suitable for maximum growth and sporulation of the fungus. Dr Brook has found that the spores of *S. bakeri* are distributed through the air in dry and windy periods. During the daytime, they are a more or less constant feature of the air flora, unless it is raining. He has developed a volumetric spore trap for sampling paddocks, but data obtained with this instrument still have to be correlated with spore counts from comparable grass samples and with the occurrence of facial eczema.

Dr Thornton, at Soil Bureau, has also been concerned with the development of a spore-counting technique—*e.g.*, 25 g of fresh grass are added to tap water (250 ml plus a drop of Teepol) and shaken vigorously by hand for 1 minute in a 2 lb Agee preserving jar. The contents are passed through a 2 mm sieve. Then counts are made with a Neubauer counting chamber by examining five 1 sq.mm grids.

To obtain a representative sample from each field, ten separate samples are taken at equal intervals along each of the two diagonals. Two separate counts are made on each sample. The technique has been applied to samples from a number of locations, including the Department of Agriculture trial area at Manutuke.

Results suggest that the provision of freshly cut or freshly damaged plant material, either by mowing or harrowing, induced a high spore count. The fungus was observed to colonize recently cut grass and the cut edges of the growing grasses.

Face wool taken from sheep on one of the fields gave a very high spore count. Hence there is the possibility that the sheep itself may provide a quick field method of sampling for the presence of spores of *S. bakeri*.

In a pure perennial ryegrass area at Palmerston North, run jointly by Massey College, Plant Chemistry and Grasslands Divisions, Dr Thornton found a moderate spore load. However, on a strip which was mown across the field, the count went up very markedly within a few days. On an adjoining paddock where a pure stand of short-rotation ryegrass was practically wiped out by an attack of Argentine stem weevil, no *Sporidesmium bakeri* was detected, despite the provision of adequate dead leaves. In the perennial ryegrass area, evidently both the microclimate and

food supply were favourable to *Sporidesmium* growth, whereas in the short-rotation ryegrass area the food was present, but, owing to complete killing of nearly all herbage, the microclimate was not favourable.

It is interesting to note that, in Dr Thornton's sampling, a tenfold variation between samples was detected across the paddocks. This illustrates how localized the infection may be.

Dr D. J. Ross, at Soil Bureau, has been investigating the effect of various cultural conditions on toxin production and will be trying out various strains of the fungus to see how they vary with regard to the amount of toxin they produce.

So far, almost all the fungus has been grown in liquid culture on an extract of potatoes and carrots. This extract can vary according to the manner in which it is made. Therefore, it is preferable to have a medium in which all the constituents can be added in weighed amounts as pure chemicals. We then know that we have a completely reproducible growth medium. Dr Ross is working on this in conjunction with Wallaceville, where the animal testing for toxicity is carried out. He is co-operating with I. R. C. McDonald, Dominion Laboratory, in an examination of the metabolic products of the fungus.

Part of the toxin appears to be in spores of the fungus and part in the mycelium and culture fluid when *S. bakeri* is grown on liquid media. It has not been finally determined whether spores alone or the whole culture are the best material for the chemists to use for the extraction of the toxin. Dr T. R. Vernon, at Plant Diseases Division, has been doing somewhat similar things to Dr Ross, but has concentrated more on a method of producing large quantities of spores. He has found that spores from the fungus after seven days' growth on sterilized ryegrass, when tested by ginuea pig feeding, were highly toxic. Dr Vernon has produced more than ½ lb of spores for the chemists at Ruakura.

Soil Bureau has grown a large amount of fungal material for other institutions—*i.e.*,

Ruakura Animal Research Station

(1) Extract from 990 bottles of cultures of *S. bakeri* for chemical work on toxin.

(2) 10 g of spores. (Grown on ryecorn seed, a technique developed by R. T. J. Clarke and B. Lloyd at Plant Chemistry Division.)

Wallaceville Animal Research Station

(1) 250 bottles of culture of *S. bakeri* for the development of a quantitative guinea pig assay.
(2) 250 bottles of *S. bakeri* for sheep feeding trial.
(3) 250 bottles of cultures of *Stemphylium dendriticum* for sheep feeding trial.
(4) 12 g of spores of *Sporidesmium bakeri* for vaccination work.
(5) 36 g of spores of *S. bakeri* for sheep feeding trials.
(6) 660 bottles of cultures of *S. bakeri* for further sheep feeding trials.

Dominion Laboratory

Sundry cultures of *S. bakeri* and *Stemphylium dendriticum* grown under different conditions for studies with infra-red and ultra-violet light absorption and with paper chromatography.

Fats Research Laboratory

330 felts of *Sporidesmium bakeri.*

Grasslands Division

This division has concerned itself in a number of ways with research on facial eczema. Dr K. J. Mitchell collected information from weather records and, in conjunction with T. O. Walshe, of the Meat and Wool Board's Economic Services, and N. G. Robertson, of the Meteorological Office, suggested a somewhat different basis for the issuing of facial eczema warnings. Dr Mitchell also tried out the technique of spraying the pasture with copper sulphate to control the disease. The experiment was successful, though from the practical point of view the level of copper in the liver of the animals from the sprayed area was near the lethal level. This last season, Dr P. D. Sears and V. C. Goodall have repeated this trial with a greater number of animals. In this case, 8.0 lb of copper sulphate were applied in fine dressings between 11 December, 1958, and 19 February, 1959. The essential aim was to obtain a prevention of the build-up of fungus.

Between 26 February and 4 March, of 16 animals on the unsprayed area, all showed liver damage, while only 1 of 14 on the sprayed area did so. As with Dr Mitchell's trial, the lambs on the sprayed area showed high liver copper levels.

From the laboratory and glasshouse work done by Dr Brook at Plant Diseases and B. Janes (seconded from Imperial Chemical Industries (N.Z.) Ltd.) at Grasslands, it would be expected that the amount of copper applied would not, in fact, reduce the fungal

population. The only other explanation appears to be that the copper has in some way protected the animals from liver damage. It is obvious that this work will have to be repeated and extended. In the meantime, farmers should not use copper sulphate as a preventive measure because of its toxic effect on the animal.

Dr Mitchell was able to establish *Sporidesmium bakeri* on ryegrass in his controlled environment glasshouses. These were of considerable use in supplementing field observations on the habits of the fungus and for fungicide trials. The results at Grasslands and Plant Diseases with fungicides do not give much hope that their use will lead to a practical method of control in the field.

Dr P. C. Barclay, of the Plant Breeding Section, Grasslands Division, set out to determine whether there were any pasture plants on which *S. bakeri* did not grow so that perhaps a safe pasture could be recommended. Dr Barclay found, as did others mentioned above, that the fungus grew well and spored profusely on dried leaves of practically all species. Yorkshire fog, of the grasses, supported the most prolific growth, while suckling clover and *Lotus uliginosus* were the most susceptible legumes.

The fungus grew and spored well on the freshly damaged leaves of many species, while on others, such as sweet vernal, white and red clovers, the fungus behaved as though they contained inhibitors to its growth. The expressed juices and extracts of these have been tested and anti-fungal substances shown to be present. Red clover and sweet vernal have been selected for further studies. Dr E. Wong, of the Plant Chemistry Division, is undertaking chemical studies to isolate and characterize the active anti-fungal principles.

Plant Chemistry Division

The large-scale extraction of toxic grass carried out by J. G. Fraser has already been mentioned, as has Dr Wong's work on the extraction of anti-fungal materials from pasture species. Dr Butler is interested in the chemical composition of rapidly growing ryegrass, particularly in connection with the hogget ill-thrift problem. This work, however, is also of interest from the point of view of nutrition of the fungus.

It has not been finally determined as yet whether the sheep obtains all or only part of the toxin from the ingestion of spores. Dr Butler is conducting experiments to see whether the toxin can be taken up by grass roots and translocated to the green leaves of the plant.

Facial eczema has occurred in three successive years on the ryegrass strain trial area and the opportunity has been taken to attempt to correlate beaker test on the grass with toxicity as measured by grazing sheep. One of Dr Thornton's original strains of fungus was isolated from this area on Massey College.

At one stage in the partial purification of the toxin, Dr D. D. Perrin at Ruakura showed that evaporation of a particular chromatographic fraction in a beaker left a white deposit. Although the substance responsible was not itself toxic, its presence was found to be a good guide to the presence of toxicity in the sample. The structure of "beaker test substance" is of importance for the light it may throw on the chemical nature of the facial eczema toxin. Its chemical relationship to compounds produced by other members of its group of fungi is also of great interest. Thus, while these latter are all antibiotics, "beaker test substance" has not so far been shown to have antibiotic activity. Dr D. Russell, one of the four facial eczema research fellows appointed by the Department of Agriculture, is working on the problem of elucidating the structure of the beaker test substance and of similar substances from other fungi which can give a false beaker test.

Dominion Laboratory

Most of the facial eczema work at Dominion Laboratory has been carried out by I. R. C. McDonald and involves the use of a double-beam infra-red spectrophotometer. This is one of a number of instruments now widely used by organic chemists to help determine what type of chemical compounds they are dealing with. The chemists at Ruakura, Soil Bureau, and Fats Research Laboratory send their extracts to Mr McDonald for examination. It is hoped that some difference may be seen between toxic and non-toxic samples which can give a much simpler index of toxicity than the four-week guinea pig test.

Other methods of extracting various fungus strains and examining the constituents are also being employed by Mr McDonald in collaboration with Dr Ross, of Soil Bureau. These studies, particularly on the amino acids, may lead to an understanding of how the toxin and beaker test compound are formed. The suggestion is that a closely related series of peptides exists in the fungal extracts and that probably one or several of these is, in fact, the toxin.

FATS RESEARCH LABORATORY

Sporidesmium bakeri, in common with many other fungi, contains fat globules. It is not considered that this fat has anything to do with the toxic principle, but the study of the fat is useful in obtaining a better overall picture of the fungus. The fat composition could help the taxonomist in differentiating strains of the fungus, and this could be allied to degree of toxicity.

Fats Research Laboratory also have a specialized piece of equipment which has revolutionized fat analysis in the last few years. The method used is known as gas-liquid chromatography and was developed in part by Dr A. J. P. Martin, who shared with Dr R. L. M. Synge a Nobel Prize for their work in other branches of chromatography. Dr J. C. Hawke is the expert on the use of this equipment, while others working on the fungal fat under the direction of Dr F. B. Shorland are L. Hartmann and Dr Isobel M. Morice.

* * * *

The work being carried out by the various divisions has been dealt with separately. It should be emphasized, however, that they are all working together and with the Department of Agriculture. Specialists and special equipment are being employed in their own divisions rather than one institution trying to obtain all the costly and complicated equipment under one roof. Only part of the work is connected with providing a direct method of control, but all is directed at obtaining as much information as possible about *S. bakeri* and its habits. Sometimes the indirect approach provides the best answer in the long run.

Regular meetings of workers from the Department of Agriculture and D.S.I.R. are held to pass on the recent results. From the amount of effort involved, it should not be too long before an answer is obtained to the question: "Why, of all the possible pastoral areas in the world available for fungal infection, does *Sporidesmium bakeri* cause facial eczema in New Zealand?"

DISCUSSION

Q:: *How was the copper-cobalt mixture applied at Manutuke? Was it dry or wet? In Dr K. J. Mitchell's experiment, the material was put on as a spray.*

DR J. F. FILMER:: In the trial using 5 lb copper sulphate and 5 oz cobalt sulphate per acre, these were applied dry mixed with superphosphate. In the trial in which a larger quantity of copper sulphate was applied, part

of it was sprayed on in solution, the pattern of the trial being exactly the same as in Dr Mitchell's experiment.

Q:: *It was stated that New Zealand is the only country in which facial eczema occurs. Does it not occur in Australia and South Africa?*

DR FILMER:: Diseases in which liver damage and photosensitization occur have been reported in South Africa, Australia and other countries. These are caused by plants which are not associated with facial eczema in New Zealand. The diseases themselves also differ from facial eczema. As far I am aware, facial eczema has not been reported outside New Zealand.

Q:: *In the experiment discussed by Dr Filmer in which the effects of mowing and harrowing were compared, he did not mention whether the lambs on the control plots were unaffected by facial eczema.*

DR FILMER:: Liver damage occurred several weeks earlier in the mowed paddocks than in the control paddocks and was more severe. Harrowing also greatly increased the toxicity of the pasture.

Q:: *Hay will normally contain a higher proportion of ryegrass and Yorkshire fog—grasses which are ideal for the growth of* S. bakeri. *Why is it that such hay is safe for stock feeding?*

DR FILMER:: This is one of the many questions which cannot be answered satisfactorily at present. However, hay is cut in late summer when pasture does not produce liver damage.

Q:: *What progress has been made in the investigations of salmonellosis, a disease which constitutes a considerable risk when sheep are shut up for facial eczema precautions?*

DR FILMER:: The salmonella problem is a very complex one. Healthy animals can carry the infection which causes trouble only when they are subjected to some form of stress. It is not surprising that shutting up should cause trouble. In general, however, where adequate hay has been fed, losses have not been severe and even where they have occurred have been less than those often experienced in severe outbreaks of facial eczema.

Q:: *I take it that there is no cure yet for facial eczema?*

DR FILMER:: There is no known cure for facial eczema and the nature of the liver damage makes it unlikely that one will be found. We are looking for the way to prevent facial eczema, not for cures.

Q:: *It is probable that in the North Island and the north of the South Island more superphosphate has been applied than in any other part of the world. Is this related to the incidence of facial eczema?*

DR FILMER:: Some of the worst outbreaks of facial eczema in Poverty Bay and Hawke's Bay have occurred on paddocks which have never been top-dressed with superphosphate.

Q:: *Has the fungus been found on choumoellier, turnips, or swedes?*

DR A. T. JOHNS:: It appears to be able to grow on practically all dead plant material but has not so far been found on these crops.

DR FILMER:: In March, 1958 when spores were common on pasture litter and liver damage was occurring in grass paddocks at Manutuke, no spores could be found on dead turnip leaves in an adjoining paddock.

Q:: *Does Dr Mitchell refute the claim made previously that the occurrence of facial eczema can be predicted by using the grass minimum temperature?*

DR K. J. MITCHELL:: The conclusions formed from the work carried out by Mitchell, Walshe, and Robertson were, first, that the potential danger of a season could be assessed from soil moisture and temperature conditions during November and December and, secondly, that the earliest time at which liver damage would appear could be predicted from the occurrence of periods of high "grass minimum" temperatures and rain. The third group of high "grass minimum" temperatures with moderate rain was judged the first potentially dangerous period. Beyond that it was not possible to state definitely how closely subsequent occurrence of liver damage was associated with periods of high "grass minimum" temperatures with rain. This is because suitable data are not available. Although the indications are that there is a reasonably close association, many other factors can influence the later re-occurrence and the duration of toxic conditions in a pasture.

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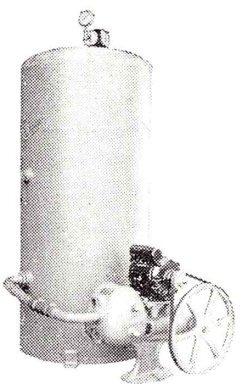

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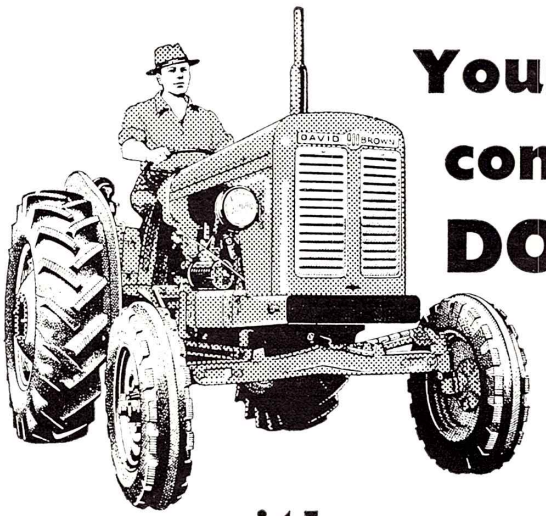

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NEW ZEALAND-TYPE MUCOSAL DISEASE

R. M. SALISBURY*

BETWEEN FEBRUARY AND JULY, 1959 there were eight outbreaks of a disease in cattle which has been called New Zealand-type mucosal disease. Whilst this disease has many features in common with mucosal disease as described in America, there are some essential differences which make it imperative that an independent approach be made in this country to elucidate its true nature and cause. Six of the outbreaks have occurred in the Wairarapa, one in Hawke's Bay, and the other at Palmerston South. Originally there was some suggestion that the disease had spread by indirect contact from the first to the second outbreak but in the light of more recent experience it would seem that all outbreaks have occurred independently of one another. Work is proceeding at Wallaceville on the disease but all that can be stated at this time is that progress has been made.

OUTBREAK NO. 1 (WAIRARAPA)

This outbreak occurred on a highly-improved property in the Carterton district in a group of 185 rising two-year-old dairy heifers of mixed breeds (Jersey, Ayrshire, Friesian) running together with six 18-month-old bulls. These animals were owned by twelve different farmers and were brought together on this property for summer grazing. The first group of animals arrived on the property in late September and the last on 4 December, 1958.

The animals were grazing over an area of 200 acres of high-quality pasture and at the end of January they were given access to 45 acres of wheat stubble and 15 acres of pea stubble.

The first indication that some animals were not thriving was at the end of January and the first death occurred on 4 February. There was no post-mortem examination carried out.

On 15 February three animals were found dead and there were several others obviously very sick. Examinations were carried out by club veterinary surgeons. In view of the serious nature of the outbreak, Wallaceville veterinarians were called in and material collected for detailed study. A tentative diagnosis of mucosal disease was made and the Director of Animal Industry Division was notified for any action he considered necessary.

Wallaceville Animal Research Station Private Bag, Wellington.

Animals continued to die and within seven days deaths had reached 39 and when the remaining animals were slaughtered (under the Stock Act) on 16 March the number dead totalled 52.

OUTBREAK NO. 2 (WAIRARAPA)

On 9 April a club veterinary surgeon reported deaths on a property $1\frac{1}{2}$ miles from the first outbreak and post-mortem examinations carried out by two Wallaceville veterinarians on two animals supported the tentative diagnosis of mucosal disease.

This outbreak involved forty-two 20-month-old Aberdeen Angus cattle. There were five deaths and at the time of slaughter of the in-contact animals two further cases were found.

OUTBREAK NO. 3 (WAIRARAPA)

On 14 April another outbreak was reported on a property five miles away from the second outbreak. Only three animals were involved, one of which died and the remaining two in-contact animals were destroyed; one of these showed early lesions.

OUTBREAK NO. 4 (WAIRARAPA)

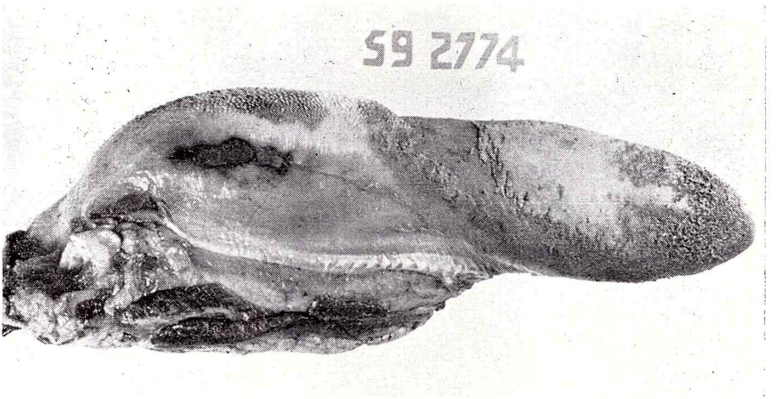
This involved one cow which was one of a small herd of seven house cows on a large grazing property in the Masterton area. These animals had access to acorns and this was the first occasion that there was any reported association between the disease and acorn poisoning. The affected animal showed identical lesions with those seen in the first three outbreaks.

OUTBREAK NO. 5 (WAIPUKURAU)

This occurred in a mob of 50 home-bred Aberdeen Angus 18-month-old cattle. They had been grazing for one week in a paddock in which there were oak trees and many acorns. On removal, 40 of the most forward beasts were taken to another property. The remaining ten were not in very good condition and about ten days later it was noticed that several were losing condition rapidly. Three of these animals were slaughtered in the advanced stage of the condition and the findings were identical with those in the other outbreaks.

OUTBREAK NO. 6 (MARTINBOROUGH)

The animals involved in this outbreak were twenty 18 to 20-month-old Aberdeen Angus cattle and two dairy cows which had been grazing in a paddock with access to acorns for about one week. They were normal when removed but ten days later several were noticed to be very sick. Altogether, seven animals were destroyed and showed a similar picture on post-mortem examination.



Tongue showing ulceration on the dorsum and scaling of the surface epithelium.

Outbreak No. 7 (Palmerston South)

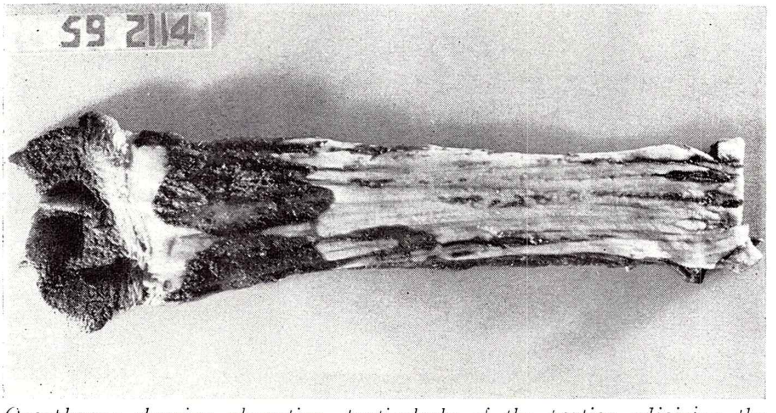
This also involved two-year-old in-calf beef cattle which had had access to acorns and the lesions were identical with those previously seen.

Outbreak No. 8 (Wairarapa)

The affected animals were a group of three Aberdeen Angus steers aged 20 months, that had been running together in a paddock with access to acorns for a period of one week. They had been taken out of the paddock twelve days previously and since that time had access to grass only. One of the three steers was visibly affected and was losing weight rapidly and, when slaughtered for post-mortem examination, showed the typical lesions as seen in all other cases.

Nature of the Disease

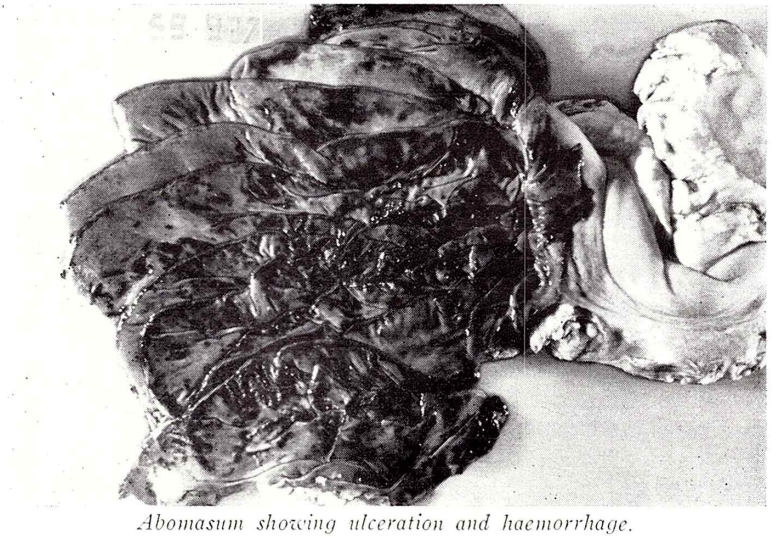
With one exception the disease has been confined to young cattle 18 to 24 months of age. Affected animals lose condition rapidly and show a brownish-green scour. They do not eat but continue to drink. They remain quite bright in the eye and show no discharge from the mouth, nostrils, or eyes. In the late stages they move with a stiff proppy gait but there is no evidence of any involvement of the feet. In about 30 per cent. of the cases that have been examined there are ulcerations of the gums, cheeks, and tongue. There is invariably ulceration of the oesophagus, particularly of the distal portion before it enters the rumen. There was no evidence of ulceration in the rumen but in a number of



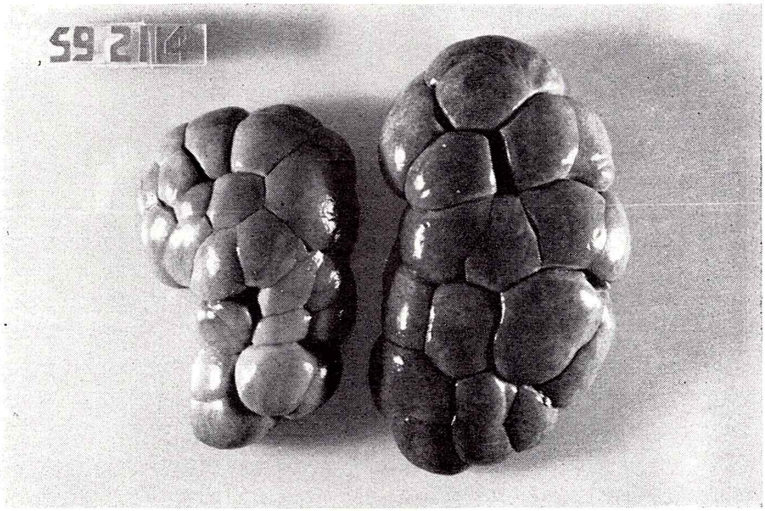
Oesophagus showing ulceration, particularly of the portion adjoining the rumen.

cases there was severe ulceration of the folds of the omasum (third stomach). In all cases the abomasum (fourth stomach) was affected and this varied from a severe haemorrhagic abomasitis with free blood present to a gross oedema of the folds and wall.

The small intestine is not usually involved and at most there is a mild enteritis. In the large bowel there has been a severe inflammation of the caecum and colon with the presence of free blood in many cases.



Abomasum showing ulceration and haemorrhage.



Kidneys showing very pale cortex.

Gross kidney damage has been a constant finding and in some cases there has been a severe oedema around the kidneys in the kidney fat.

With the exception of the first outbreak, the mortalities have not been serious and there was some indication that on the first property some of the affected animals which were destroyed last were recovering.

Laboratory Findings

Material was examined for all known bacterial pathogens with negative results. Material was also examined toxicologically for lead, arsenic, mercury, molybdenum, copper, and a weedicide—di-nitro-butyl-phenol (D.N.B.P.).

On the first property the pea crop had been sprayed with D.N.B.P. and there had been a report from Great Britain stating that pigs had been poisoned following grazing on ground sprayed two years previously with this weedicide. Dosing trials conducted at Wallaceville with this compound showed that cattle could be poisoned with D.N.B.P. at levels of 15 mg/kg liveweight or greater, but the findings on post-mortem did not resemble those seen in the field. It is extremely doubtful if there

would be sufficient D.N.B.P. still present on the pea crop after an interval of several months to have had any adverse effect on grazing animals.

Virus Studies

A virus has been isolated from the animals studied which is neutralized by blood sera from animals with American-type mucosal disease. These sera were kindly supplied to us by a laboratory in Indiana, U.S.A. Further sera have been received from Iowa, U.S.A., and these are at present being examined.

A similar type of virus has been recovered from all cases of the New Zealand-type mucosal disease studied to date and work is continuing with this virus to determine its significance.

It is of interest to note that in the original outbreak a number of sera taken from animals at the time of slaughter will also neutralize this virus, which would indicate that they had had some contact with it. It was also noted that the mortality rates in the stock from different owners varied considerably, the majority of deaths being in stock from three owners and these properties were contiguous. Another owner who had 31 cattle on the property lost only one beast. This fact might indicate that an infective agent is involved and that certain lines of cattle were susceptible and others were resistant, as a result of some previous exposure to the disease.

Transmission Studies

Material from infected animals has been inoculated into susceptible young cattle and a mild disease has been reproduced, as indicated by temperature reaction at the 7th to 8th day, a fleeting diarrhoea, and ulcers in the mouth. This is in line with work done in the U.S.A. and Great Britain where the typical disease, as it occurs in the field, has not been reproduced.

Acorn Poisoning Studies

It will have been noticed that in the last five outbreaks of the disease there has been a close association with access to acorns in the period up to 14 days prior to animals being noticed sick. This might well have been a very satisfactory solution to the

problem except that on the first three outbreaks there was no such association.

Acorn toxicity is being investigated and to date acorns have been proven to be toxic. Acute acorn poisoning seems to be primarily associated with liver damage and in the chronic form there is kidney damage similar to that seen in mucosal disease. This work is being carried further.

Discussion

New Zealand-type mucosal disease would appear to be primarily a virus infection, but some other stressing factor or factors is required before the virus becomes pathogenic. The virus isolated has been common to all outbreaks of the disease to date and in five out of the eight outbreaks acorns have been associated. With the exception of the first outbreak, the majority of cases have been chronic in nature and examination of the kidney has indicated that animals were affected for at least 4 to 6 weeks prior to death. Much work has still to be done to elucidate the true nature of the condition and this is being pursued with vigour. Progress will be reported through the usual channels from time to time.

DISCUSSION

A MEMBER: I have 10 acres of oak trees on my farm and both the sheep and cattle have regularly grazed amongst them, but I have never known the stock to be affected in any way.

A:: We have shown by experimental feeding that acorns are toxic for cattle and we have reports of sheep being poisoned by acorns. Some cattle may not eat them even though they have had access to them.

Q:: *Why were pigs killed on one property where mucosal disease was reported?*

A:: I was concerned primarily with the diagnosis of the disease and was in no way involved in the implementation of the Stock Act. I would prefer, therefore, that this question be answered by those concerned in carrying out the slaughter policy.

Q:: *A neighbour had samples taken from breeding cows and sent to Wallaceville for a fertility test. The report received also stated that traces of mucosal disease were present. Would this be true?*

A:: There must be some mistake in the interpretation of the laboratory report because no material submitted for infertility tests would be examined for mucosal disease.

Q:: *Does the speaker think the disease has been in New Zealand for some considerable time or is it a recent introduction?*

A:: We have reason to believe that the disease has existed in a milder form, but we had certainly not experienced such an acute outbreak as that in the first outbreak at Carterton.

Q:: *Is the mortality rate in the New Zealand-type disease as great as in the U.S.A.?*

A:: Whilst the mortality rate was high in both U.S.A. and New Zealand, the course of the disease was much more rapid in New Zealand. In the U.S.A. where 25 per cent. mortalities may be recorded, this would extend over a period of months, whereas in New Zealand a similar mortality occurred in a matter of 2 to 3 weeks.

Q:: *Has mucosal disease been reported in any countries other than New Zealand and U.S.A., and have there been any control measures developed?*

A:: Mucosal disease has also been reported in Great Britain and Australia. No control measures have been adopted in any of those countries where the disease has been reported.

Q:: *Is it possible for the disease to be transmitted from one animal to another by physical contact?*

A:: The only reports of direct transmission from animal to animal emanate from North Dakota where it is claimed that such a transmission has resulted by the interchange of drinking utensils.

Q:: *Is it possible that birds may transmit the disease?*

A:: No opinion could be expressed as to whether birds could transmit the disease. We have failed to date to transmit the disease by all known routes.

Q:: *Were there any other animals running in the same paddocks as the cattle which contracted the mucosal disease?*

A:: There were 31 hoggets running in the same paddock as the cattle in the first outbreak. These continued to thrive and went away to the works in fat condition.

Q:: *Could any of the animals slaughtered have recovered?*

A:: There was some evidence that, at the time of slaughter of the remaining 139 animals on the first property, some of the affected animals were recovering. Blood T.N.P.N. (total non-protein nitrogen) levels indicated that of these animals 25 were either in the incubation stage of the disease or were recovering.

Q:: *Is it not true that in the U.S.A. the disease is carried by species of deer?*

A:: Mucosal disease in deer has been recorded by North Dakota workers.

Q:: *Has not the transmission by deer also been reported from Germany?*

A:: I have not seen any reports to this effect.

Q:: *Is there any evidence from other countries that acorns are associated with the disease?*

A:: In Great Britain this disease complex has been called "acorn poisoning" by veterinary practitioners.

Q:: *Do seasonal conditions, such as those experienced in Hawke's Bay this year, have any bearing on the outbreak of the disease?*

A:: This has been a bad year for young cattle in most areas, and there might be some association with seasonal conditions and these outbreaks of mucosal disease.

Q:: *Is there any possibility that the disease may be transmitted in the meat?*

A:: Indications are the disease was not very infectious and as affected animals lost condition rapidly it was most unlikely that they would be killed for meat.

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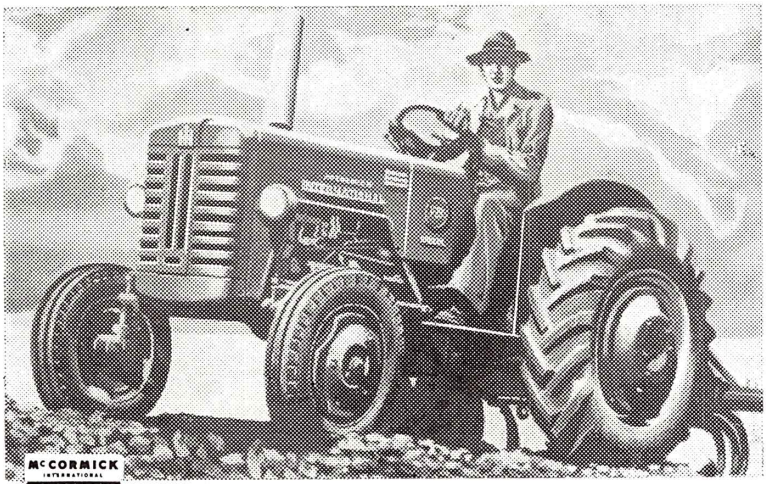

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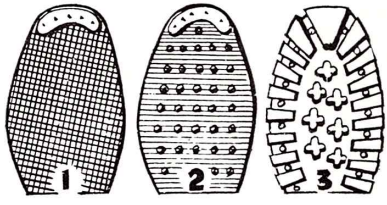

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SELENIUM AND ANIMAL HEALTH

C. DRAKE, A. B. GRANT, and W. J. HARTLEY*

UNTIL TWO YEARS AGO, selenium was of importance in animal health only on account of its poisonous properties. In certain areas of the world, particularly the arid western regions of the U.S.A., the soils contain toxic amounts of selenium. In these seleniferous areas, the common cereal and pasture plants may contain from 20 to 30 p.p.m. of selenium, and certain weeds may contain up to 10,000 p.p.m. of the element.

It is considered that levels of as low as 5 p.p.m. can produce chronic selenium poisoning in animals. In cattle, a disease called blind staggers is attributable to chronic selenium poisoning; in horses, there is a loss of hair from the mane and tail together with mis-shapen hooves. Because of the possibility of selenium poisoning in humans eating foodstuffs grown on seleniferous soils, most countries, in their food and drug Acts, stipulate that foodstuffs shall contain no selenium.

How, then, does a highly toxic element like selenium come to be used in the control of white muscle disease in sheep and hogget ill-thrift?

It has been known for many years that, when small laboratory animals are kept on a vitamin E-deficient diet they will develop characteristic degenerative changes in the muscles. As identical changes are seen in sheep affected with white muscle disease, vitamin E, in the form of alpha-tocopherol acetate has been widely used in New Zealand for the treatment of white muscle disease in lambs. On many properties, affected lambs appear to benefit from this treatment. Very recent work in the U.S.A. has shown that minute quantities of selenium can replace vitamin E in certain vitamin E-deficient diets. As a result of this observation, Wallaceville workers immediately carried out extensive field trials in the South Island to see if selenium could control white muscle disease in lambs.

Distribution and Incidence of White Muscle Disease

White muscle disease is prevalent in the South Island, particularly in Canterbury and Central Otago. Recently, sporadic

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cases have also been reported on the pumice soils in the Rotorua-Taupo area. It occurs from September to January, and is seen in lambs from birth up to three or four months of age. Losses have occurred in lambs of all breeds out of ewes of all ages, including hoggets. The congenital form has occurred only in property-bred ewes and not in ewes that are brought in just prior to mating from other areas. Losses have been more severe in some years than in others, and even on one property one mob of lambs may be badly affected and other mobs may be unaffected.

The majority of outbreaks of white muscle disease have occurred on country classified as stony silt loams and which was, until recently, in native pasture and largely "run out". Following ploughing, seeding with improved pasture strains, the liberal application of phosphatic fertilizers, and in some cases also the introduction of irrigation, this type of country now produces lush autumn and spring growth, particularly of clovers and lucerne.

Most outbreaks of white muscle disease are seen at pasture and are apparently unassociated with exercise. On some properties, however, where there have been only a few cases on pasture, driving has precipitated a severe outbreak. On a few properties, outbreaks are seen only immediately following driving. The incidence of white muscle disease in an affected mob at pasture is rarely greater than 50 per cent., but following driving it may reach 100 per cent. The mortality usually does not exceed 20 per cent.; however, more than 50 per cent. of affected lambs may die in outbreaks precipitated by driving. In the congenital form, up to a half of the lambs born may die as a result of white muscle disease. In these instances, there are usually only relatively few losses from the disease in lambs more than a week old.

Signs of White Muscle Disease

The disease is seen in two forms—the congenital form where the lamb is affected at birth, and the delayed form which usually does not become apparent until the lamb is a few weeks old. In the congenital form, lambs are either born dead or die suddenly within a few hours to three days of birth. In the delayed form, which is more common in lambs three to six weeks of age, the lambs show a stiff stilted gait with an arched back, are disinclined to move about, lie down a lot, lose condition, and, if badly affected, become prostrate and die from starvation or exposure. Less severely affected lambs often make a slow recovery provided

they are able to walk about and feed. Lambs with severe heart involvement may die suddenly without any prior signs of stiffness. On some properties, affected lambs have shown a profuse diarrhoea.

The signs shown by lambs affected with white muscle disease could be confused with cases of foot rot, "scald", arthritis, or tetanus. However, once a post-mortem is carried out, there should be no difficulty in arriving at the correct diagnosis.

Post-mortem Findings

In the congenital form, the lamb may be born dead, or may have survived the birth process and have walked and in some cases also have had a feed. In these lambs, there is an excess of a clear fluid, often with gelatinous clots, in the chest and abdominal cavities and also in the heart sac. The heart shows localized to widespread chalky white discoloration of the walls of the chambers and, in some cases, the muscles of the thigh, loin, and shoulder are either paler than normal, show white striations, or are of a uniform chalky colour.

In the delayed form, similar abnormalities are noticed, but they are usually more severe in the limb musculature.

The changes in the heart and limb musculature are the result of death of the muscle fibres, which then become calcified. Affected limb musculature will regenerate, but affected heart musculature does not.

Prevention and Control

As mentioned previously, the use of selenium has been explored in the prevention of white muscle disease in lambs.

Ewe Trials

On three properties experiencing outbreaks of congenital white muscle disease, the 1,200 ewes remaining to lamb were divided into three equal groups. One group received 5 mg selenium as sodium selenate by mouth, one group received 300 mg of alpha-tocopherol acetate by mouth, and the other group received no treatment. The outcome of these trials, summarized in Table 1, confirms the previous observations that vitamin E given in late pregnancy does not protect the lamb from the disease. However, selenium treatment at such a late stage of pregnancy does appear to have been of some value.

TABLE 1: Effect of Selenium and Vitamin E Treatment on Neo-natal Lamb Mortality

Ewe treatment	*Lamb deaths attributable to:*	
	White Muscle Disease	*Other causes*
Selenium	20	20
Vitamin E	54	25
No treatment	41	18

LAMB TRIALS

On 16 properties that had previously experienced the delayed form of the disease, lambs were divided into three equal groups at docking. One group received 1 mg selenium as sodium selenate, one group received 300 mg alpha-tocopherol acetate, and a third group received no treatment. On seven properties, the selenium and alpha-tocopherol acetate was given as one subcutaneous injection; in the remainder, these agents were given by mouth weekly until the lambs were from two to three months old. The disease appeared on 11 of the trial properties, but in no instance were there severe outbreaks. The results of these trials are summarized in Table 2. It is seen that vitamin E had some effect in preventing the disease, whilst selenium almost completely prevented it.

TABLE 2: The Effect of Prophylactic Treatment of Lambs with Selenium and Vitamin E in the Prevention of White Muscle Disease in Lambs.

Losses attributable to white muscle disease		
Selenium groups	*Vitamin E groups*	*Controls*
2	21	50

Recommendations

In the event of an outbreak of the congenital form of white muscle disease, it is suggested that all ewes yet to lamb be given selenium. On properties that annually experience the delayed form of this disease, it is suggested that the ewes be given a dose of selenium two or three weeks prior to lambing, with the lambs receiving a dose at docking. When an outbreak of the disease

occurs in lambs, it would be sound practice to give selenium to the remainder and treat affected ones with vitamin E (Wallaceville workers have not yet had any experience of the treatment of the disease by selenium).

Hogget Ill-thrift

Hogget ill-thrift is the name given to an ill-defined condition in which lambs fail to thrive in the presence of abundant, apparently highly nutritious, pasture. It is seen in two forms. One form occurs any time from November onwards and is seen in both Islands. It is usually relatively insidious in onset, may be spread over several months, and has a variable mortality. The other form characteristically occurs in the North Island after the warm early autumn rains and appears to be directly associated with unattractiveness of the fresh growth of grass.

The known causes of the insidious type of ill-thrift are cobalt deficiency and internal parasites. The major contributing cause is not yet known; preliminary investigations indicate that it may in part be due to selenium deficiency.

One of the most severely affected areas experiencing the insidious form of ill-thrift is the newly brought in clover-dominant pumice country in the centre of the North Island. As white muscle disease was recently reported in this area, the possibility of selenium alleviating this ill-thrift was explored. Controlled trials were instituted in January, 1959, on eight badly affected farms in the Rotorua-Taupo area, where farmers had lost from 10 to 40 per cent. of their lambs after docking.

On each property, ill-thrifty lambs were randomized into equal groups containing from 20 to 35 animals, the average weight of which at the commencement of the trials ranged from 34 to 49 lb. One group of lambs received 5 mg selenium as sodium selenate by mouth, at the start of the trial. This was repeated in two weeks and again four weeks later. All lambs were weighed at the commencement, two weeks later, and thence monthly until the trial had been in progress for ten weeks.

Figure 1 is a composite graph depicting the results of these eight trials. It shows that the average weight increase of the survivors from the selenium-treated groups was 20 lb as compared with approximately 12 lb for the survivors in the control group. Further, the death rate in the controls was between three and four times greater than in the selenium-dosed groups. Almost all the

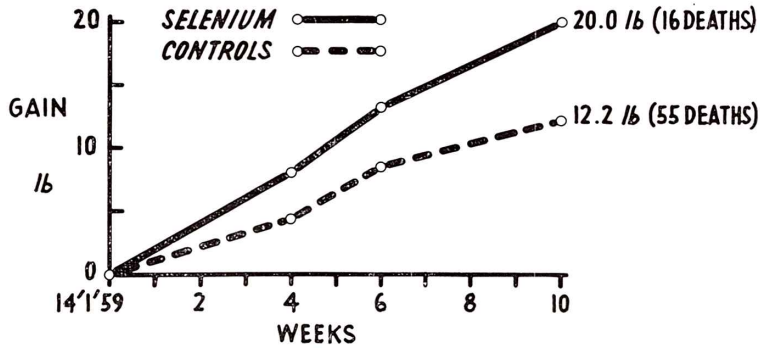

Fig. 1: Growth response to selenium—survivors of eight trials with a total of 402 sheep (Rotorua-Taupo).

deaths in the latter groups occurred within the first month, whereas the deaths in the controls occurred fairly regularly throughout the duration of the trials. Concomitant trials with cobalt, copper, and phenothiazine failed to give any weight response.

A more realistic picture in terms of loss of production from ill-thrift in these eight trials is shown in Fig. 2. This graph depicts the change in total liveweight of the selenium-dosed lambs as compared with the controls. Here the obviously much greater difference between treated and control animals is the result of death being considered as a loss in total liveweight instead of being ignored as it was in Fig. 1. As a result of the high mortality (27 per cent.) and the lower growth rate, the untreated animals

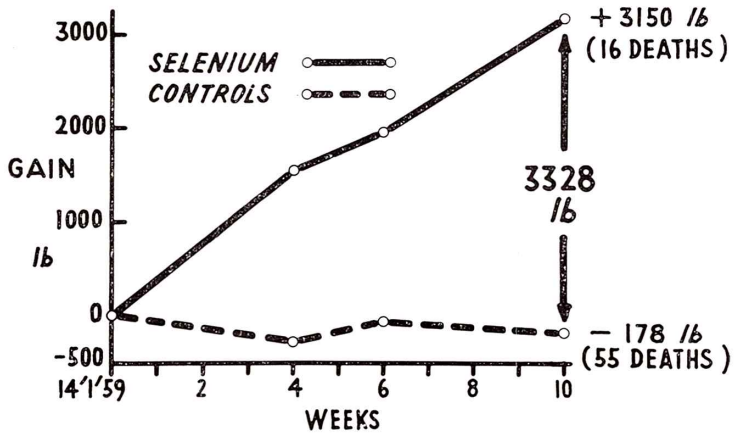

Fig. 2: Loss of production prevented by selenium.

have experienced an actual loss of total liveweight of 178 lb, whereas the dosed animals have gained 3,150 lb.

These trials clearly showed that selenium both quickly and effectively controlled outbreaks of ill-thrift in the Rotorua-Taupo area.

As a result of these encouraging observations, investigations were extended to the southern half of the North Island, where there was much ill-thrift but where white muscle disease had not been recognized. Controlled selenium trials have been conducted on 20 properties in the Wellington, Wairarapa, and Manawatu districts during the last four months.

A mild to a marked response to selenium has been obtained on the sandy coastal soils of the Manawatu. Figure 3 compares the weight gain between selenium-treated and control lambs on a property close to Flock House at Bulls; similar results were

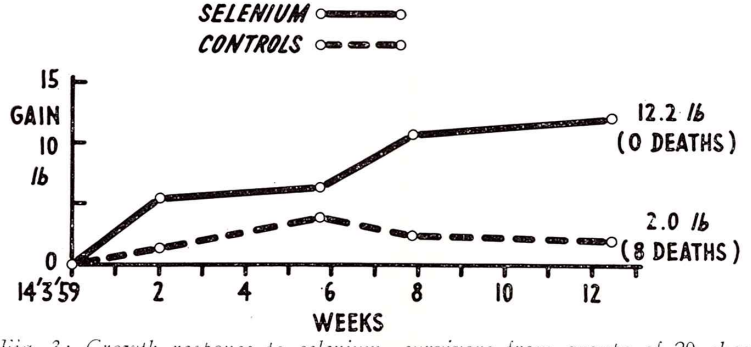

Fig. 3: Growth response to selenium—survivors from groups of 20 sheep (Bulls).

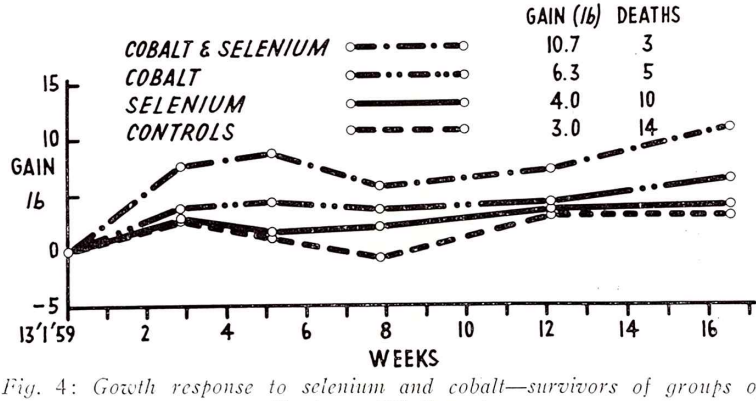

Fig. 4: Growth response to selenium and cobalt—survivors of groups of 20 sheep (Waikanae).

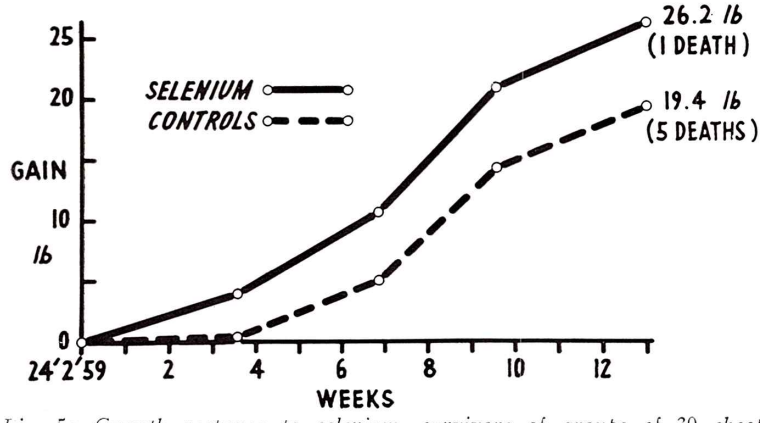

Fig. 5: Growth response to selenium—survivors of groups of 30 sheep (Greytown).

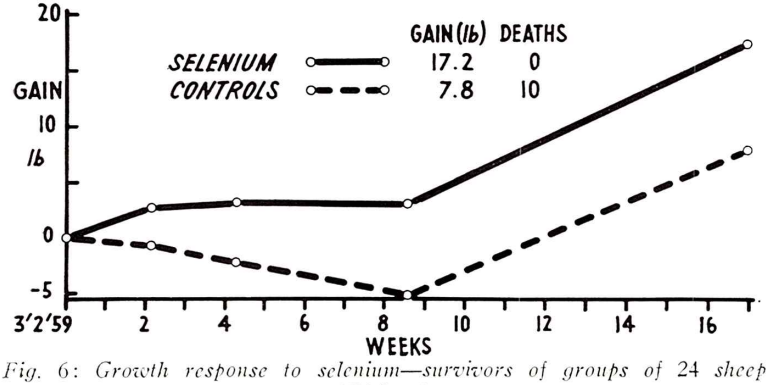

Fig. 6: Growth response to selenium—survivors of groups of 24 sheep (Pirinoa).

obtained on Flock House itself. Figure 4 shows that cobalt deficiency can mask an apparent selenium deficiency.

A mild to moderate response to selenium has also been observed on the stony soils of the Wairarapa. Figures 5 and 6 show the response to selenium in lambs at Greytown and at Pirinoa.

Similar trials have been carried out in the South Island by Wallaceville and other workers. This year was a good year for lambs in the South Island, as there was little ill-thrift; however, on a number of properties in Canterbury there was a mild growth response to selenium in thrifty and ill-thrifty lambs. It is of interest that on all properties experiencing congenital white muscle disease last season there was no subsequent ill-thrift problem in the lambs.

Concerning the autumn-flush type of ill-thrift, the only trial carried out to date has clearly shown that there was no response to selenium.

In all the investigated outbreaks of the insidious type of ill-thrift there has been some response to selenium; however, only on occasional properties has the maximum growth rate been achieved. Initial observations thus indicate that selenium, like cobalt and parasitism, plays some part in the general problem of hogget ill-thrift. It is important to realize that selenium is not the cure for all ill-thrift.

Recommendations

As mentioned previously, selenium will control certain outbreaks of ill-thrift, particularly those occurring on the light type of soils. Wallaceville workers' advice to farmers experiencing ill-thrift on pumice, sandy, and stony country is to contact their local veterinary surgeon or the local office of the Department of Agriculture with a view to carrying out a selenium trial.

It must be remembered that selenium is a highly toxic substance and that research workers have had only very limited experience in its use. The effective dose rate is not yet known, nor how frequently it has to be administered. Considerable work on selenium is being undertaken at Wallaceville, but it may be some time before it is possible to recommend unconditionally a selenium treatment that is safe, effective, and practicable.

DISCUSSION

Q:: *What has been the method of dosing and the dose rate in the trials with selenium?*

A:: So far most of the lambs have been given the selenium by mouth. The dose rate that we have employed for unthrifty lambs has been 5 mg selenium (as sodium selenate) in water once monthly.

Q:: *How was the cobalt administered in the trials where it was used?*

A:: Cobalt was given as cobalt bullets.

Q:: *At what stage would the cobalt bullet be used prior to selenium administration?*

A:: The cobalt bullet was given at the same time as the selenium.

Q:: *Has any work been initiated on the uptake or depletion of selenium from the pasture and soil with a view to getting selenium into the animal other than by dosing?*

A:: No. Work on this subject awaits the development of a more sensitive method of analysis for selenium.

Q:: *Is there any association between selenium deficiency and the dry ewe problem?*

A:: There is some circumstantial evidence that this may be so. Trials are in progress to investigate this point.

Q:: *Has selenium any effect on the wool growth of sheep?*

A:: We do not know. Investigations are in progress.

Q:: *Is there any relationship between bacterial infection and hogget ill-thrift?*

A:: Unthriftiness sometimes may be associated with secondary bacterial infection.

Q:: *Would it be possible to incorporate selenium in the cobalt bullet so as to give a prolonged effect?*

A:: Probably yes. This is being investigated.

Q:: *Does the use of selenium reduce the need for drenching against internal parasites?*

A:: No.

Q:: *Does the selenium, as used in the trials, affect the meat for human consumption?*

A:: No.

Q:: *What is the lethal dose of selenium for sheep and for humans?*

A:: The lethal dose of selenium for hoggets and ewes as one dose is about ten times that used for treatment purposes. We have not yet any data regarding the lethal dose for man. (One of us [A.B.G.] tolerated one dose of 25 mg selenium.)

Q:: *Why is selenium practically unobtainable at present in New Zealand, and from where does selenium originate?*

A:: The initial demand for selenium exceeded the supply. It is now readily available through veterinarians. Selenium is a common by-product of certain ores.

Q:: *Is selenium accumulated in the body, and in what part of the body would you expect to find the greatest accumulation?*

A:: If selenium is ingested in small amounts in the daily diet it will tend to accumulate in the body; if the levels are large enough chronic selenium poisoning will eventuate. Selenium accumulates in the liver and other organs.

Q:: *Could selenium be administered in the drinking water?*

A:: No.

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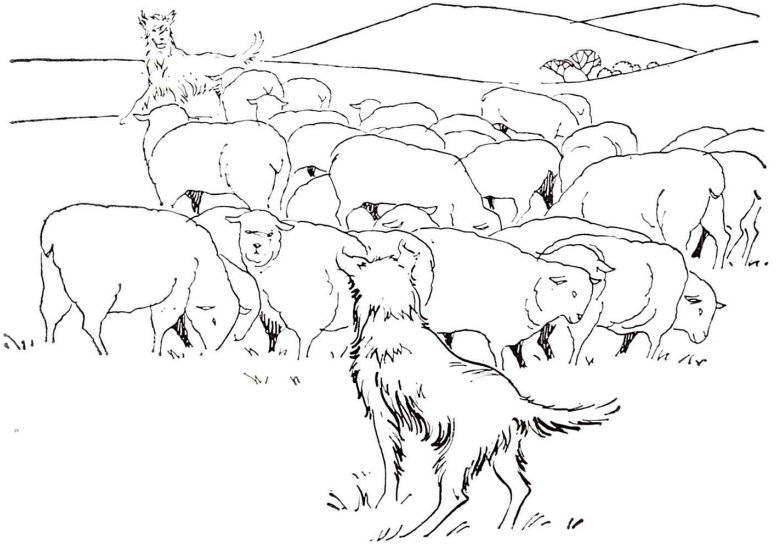

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SFA.9

RECENT DEVELOPMENTS IN CONTROL OF SOME PASTURE PESTS

J. M. KELSEY*

THIS PAPER WILL DEAL only with problems that have arisen during the past twelve months, or which have not been placed on record previously at meetings such as this.

Grass Grub Control

As many farmers are aware, the present season has been a bad one for damage by grass grub and has illustrated clearly (at least in the South Island) the desirability of having available to farmers a choice between the fine particle size D.D.T. recommended for dry-mixes with superphosphate and the coarser D.D.T. particles in wet-mix superphosphate. The difference may not appear obvious on general appearance of the two mixes, but the wet-mix is four to six weeks slower in action than is the dry-mix product. Unfortunately, there has been a shortage of fine grade D.D.T. in both Islands; the result has been that farmers had to apply the relatively coarse D.D.T. in wet-mixes. While the latter are excellent for spring and summer applications to uninfected pastures to prevent damage in the following season, their four to six weeks' delay in action can result in a complete or partial loss of the ryegrasses in a pasture. It should be remembered that, wherever grass grubs are present, a very fine particle of D.D.T. must be used.

Recent analyses by Dr B. W. Doak of the Fertilizer Manufacturers' Research Association showed that there has been a very definite and welcome improvement in the North Island's fertilizer works D.D.T. superphosphate mixes. Of 78 samples analysed, only three were below requirement after adjustment for errors in analysis. In the South Island, some works are changing from serpentine superphosphate to superphosphate compound wherever D.D.T. wet-mixes are involved; this is because of the slower field action of the coarser serpentine superphosphate. The change should be a big improvement, as the superphosphate compound from these works is very much finer and the D.D.T. spread consequently will be better. There is still a tendency in one of the older works to use machinery that is totally unsuitable for mixing D.D.T. with superphosphate and the result is consistently variable mixes.

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A great deal of the pasture land of the North Island must be treated from the air and this method of application requires urgent attention both as regards swath widths at various altitudes, and distribution from start to finish of plane runs. In general, tests by D.S.I.R. indicate that effective swath widths are not more than 33 ft at altitudes of 40 to 150 ft, and the distribution along lines of flight is too heavy for the first half of runs and too light for the rest of the run. To minimize dust nuisances or hazards, there is a tendency for plane operators to use coarser materials, and, though there are specially processed pelleted materials that give good results under suitable conditions, there are other products of similar general appearance that are practically useless for grass grub control.

Another problem that requires attention by farmers is that grass grubs are probably the main cause of weed invasion of pastures. It is quite uneconomic to apply weed control preparations and over- or under-sow if the grass grubs are left to continue their activities.

Oxycanus (Porina) Control

This pest requires more attention as there have been a number of genuine instances where D.D.T. has failed to give control beyond the one year. In practically every such case the pastures had been either cut for hay, or a seed crop taken off them. It is not clear why this residual life of D.D.T. fails as grazed pastures of the same type can usually be protected for up to three years by one application of 2 lb p.p.i.-D.D.T. per acre.

Argentine Stem Weevil in Ryegrasses

Those who grow short-rotation or Italian ryegrasses have probably found that during the past year these varieties have given very poor grazing. The culprit is a small brown weevil about $\frac{1}{8}$ in. long. It lays its eggs in pockets in the leaf sheath and the grubs tunnel into tillers to destroy the plants.

Over the past four years the D.S.I.R. has tried to work out the biology of this weevil with a view to finding the most likely stage at which it can be controlled. The adult weevil is easily killed by D.D.T. and Lindane, but tests in co-operation with the Department of Agriculture at Timaru and with Grasslands Division, D.S.I.R., at Lincoln showed that it is useless to

control adults if eggs have already been laid. This is because the grubs hatching from eggs are under cover throughout their larval feeding period and even systemic insecticides that are taken into the sapstream of plants had no effect whatsoever on larvae. Grasslands Division tests indicated, however, that D.D.T. or Lindane applied at a rate of $2\frac{1}{2}$ lb per acre just before eggs were laid gave promising results; further tests may show that lower dosage rates may be practicable.

The treatment periods for the South Island are the last two weeks in August and first two weeks in December for the two generations. In the North Island the life cycle of the weevil requires more attention as it is possible that eggs are laid two to three weeks earlier than in the South Island. Reinfestations of a treated area could be fairly rapid and therefore it may be necessary to treat against each generation.

Control measures are to apply D.D.T. or Lindane in such a way that they reach the ground surface. The insecticides must on no account be worked into the soil as the weevil does not usually move more than $\frac{1}{4}$ in. into the ground, and any factor such as heavy rain or cultivation can carry the insecticides too far below the surface to be effective. Insecticides applied to combat the stem weevil will automatically protect pastures against grass grubs and *Oxycanus*.

Cocksfoot Seed Thrips

Though this insect is not a primary pasture pest it is important in that it appears to reduce the seed yields in New Zealand by approximately 50 per cent., if inspection of heads from four paddocks this season are any indication. Mrs M. Johnston of the Department of Agriculture has been working on this thrips for some years and is publishing results shortly.

In co-operative tests with the Department of Agriculture it was found that control of adult thrips was readily achieved, but that a combination of Dieldrin and Metasystox failed to have any effect on the young nymphal stages of the thrips; in other words, the sprays gave nearly 100 per cent. control of adults but the seed yield was not increased at all. In view of this experience it is suggested that the application of insecticides should coincide with adult thrips, activity in spring, but before they commence to lay eggs (similar to the approach to control of the Argentine stem weevil). At the moment the life cycle is not known accurately

enough to make a definite recommendation. The thrips overwinters as mated females which can be found in practically any green or partly green vegetation round paddocks.

DISCUSSION

Q:: *What immunity have cocksfoot and prairie grass to the Argentine stem weevil? Would rows of eggs found on a cocksfoot seed head stem indicate thrips?*

A:: Both cocksfoot and prairie grass are attacked but, probably owing to larger diameter tillers, do not show much damage. The eggs would not belong to the seed-damaging thrips, because its eggs are laid inside flowers. The rows of eggs are more likely to be those of cicadas or other hemiptera.

Q:: *Would the speaker comment on the use of D.D.T. emulsion as a grass-grub control procedure?*

A:: Sprays could be applied only during actual rainfall, or to bare ground, as they are difficult to remove from pasture, etc., once they dry there. This is not important in itself, but may lead to contamination of foodstuffs when stock eats the insecticide.

Q:: *Is it safe to spray a paddock for grass-grub control just before sowing the seed?*

A:: Yes.

Q:: *When drilling new grass in 7 in. rows, the D.D.T. was mixed with the seed. Would this be satisfactory?*

A:: No. Some farmers have reported success with this method, but we have seen too many failures to recommend it.

Q:: *How long does it take for D.D.T. to become active when applied to short, dry pasture?*

A:: Assuming that there was at least $\frac{1}{2}$ in. of rain after application, the dry-mix D.D.T.-superphosphate with fine particle D.D.T. would protect pasture from the seventh day after the rain. The wet-mix D.D.T.-superphosphate would take 4 to 6 weeks longer.

Q:: *Would the speaker comment further on his recent suggestion of flying over the same ground twice to improve the distribution of D.D.T.-superphosphate from the air?*

A:: By that I meant that the second flight should be in a reverse direction to the first in order to overcome the decrease in amount of D.D.T.-superphosphate falling along lines of flight.

Q:: *Would the speaker explain why perennial ryegrass is not damaged to the same extent as short-rotation ryegrass by the Argentine stem weevil?*

A:: I do not know. Perhaps Dr Sears may care to comment on this question.

DR. P. D. SEARS: Perennial ryegrass has more tillers than has short-rotation, but in the face of a heavy attack perennial ryegrass can be killed also.

THE USES OF AERIAL PHOTOGRAPHY IN FARM DRAINAGE

D. G. BOWLER*

OVER THE LAST TWENTY-FIVE YEARS aerial photography has been employed on an ever-increasing scale for a variety of agricultural uses, in such sciences as forestry and geology, and for a multitude of engineering and military purposes.

This use of aerial photography comes under the heading of photogrammetry, which can be defined as the science of obtaining measurements by means of photography. This description must be amplified to include the interpretation of photographs, a function of nearly equal importance as the ability to recognize and identify a photographic image is often as important as the ability to measure it accurately.

It was known ten years ago that photogrammetry could supply an answer to many problems in farm drainage and, in fact, the first vertical airphotos of drainage systems with which Massey College was concerned were taken in 1947. However, it was not possible to be equipped for this work until recently. The Massey College Drainage Extension Service now has suitable photographic equipment, and aerial photography is being applied to farm drainage problems in the following ways.

Photoplans

Most farmers will appreciate that a carefully prepared plan, drawn to scale, of field tile installations is of at least equal importance to any other aspect of farm drainage, and all the drainage projects carried out by farmers in co-operation with the College Extension Service have always been recorded in blueprint form as a permanent record of the installation. While this form of plan is a very satisfactory one, there is frequently some difficulty in preparing a plan to portray adequately the conformation of the ground and prominent features such as buildings, fences, or plantations. In cases where a system is to be expanded to serve other paddocks in the immediate vicinity, drainage records tend to become bulky and difficult to relate to one another, particularly if a change in scale is necessary.

**Drainage Extension Service, Massey Agricultural College, Palmerston North.*

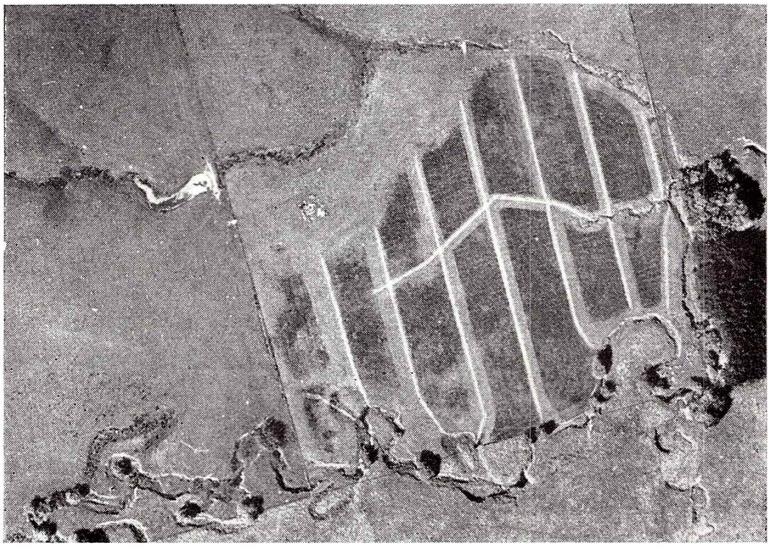

Fig. 1: A vertical airphoto of a tile drainage scheme in a rush-infected paddock.

The specially taken airphoto of completed systems overcomes these difficulties and provides what is considered to be the best kind of record of tile drain installations and their relationship to natural features and above-ground improvements.

The College Drainage Service now provides farm drainage photoplans enlarged to a suitable scale and contained in special folders on which is printed such information as tile numbers, instructions for moling and other details important as a record.

Finding Existing Systems

Countless thousands of field tiles have been installed in the farmlands of New Zealand in the last 50 years. Considerable labour and expense has been involved in these schemes, irrespective of the method of installation. Unfortunately, in too many instances, no record whatever has been kept of these schemes, and particularly in heavy clay soils the consequences can be costly where mole drainage extensions or maintenance work are involved.

A start has been made on examining the problem by means of photography, and there are some hopeful signs of a worthwhile solution.

It is known, for instance, that freshly cultivated clay soils, particularly when slightly damp, will show a colour difference near the old tile lines, no doubt due to the disturbance of subsoil and its mixing with the soil at the time of excavation. Wheat is an excellent indicator of long forgotten earthworks and archaeologists have studied the characteristics of wheat growth to identify old Roman roads in Britain. It has been observed, too, that wheat plants will usually be much greener over old tile lines and the use of this crop as an indicator of existing tile lines seems to be a most hopeful approach.

Choumoellier can also provide a strong contrast in growth over tile lines but, as it will also show growth differences according to soil texture changes, odd dry spots and finishes and feerings of plough lands, considerable care in photo interpretation is necessary. Probably the stubble stage, when a colour difference in the soil may also add to the contrast, is the most dependable approach with this plant.

A strong, vigorous pasture of predominantly ryegrass and white clover will effectively screen any sign of existing field tiles, except possibly under dry soil conditions, but on fields which are regularly and closely mown and where the clover content of the sward is kept purposely low as, for example, on playing fields, golf courses, or flying fields, there is usually plenty of evidence of tiles remaining well defined for at least 20 years.

Considerably more work needs to be done on the problem and as the seasons permit, when either soil moisture conditions and/or variations in plant cover are likely to reveal the existence of field tiles, further observations will be carried out.

Preliminary Surveys

A topographical plan of most wet areas is a desirable prerequisite to the planning of a suitable farm drainage scheme. Oblique colour photography, combined with vertical scale photographs, is proving a considerable aid to better planning, and when more is known about the art of photo interpretation for the specific purpose of field drainage there is every indication that the cost of some ground surveys, particularly the time involved in doing them, will be substantially reduced.

Photography as a means of identification of broad textural differences in soils as between heavy clays and silt loams and/or stony soils is already reasonably dependable, but the accuracy of

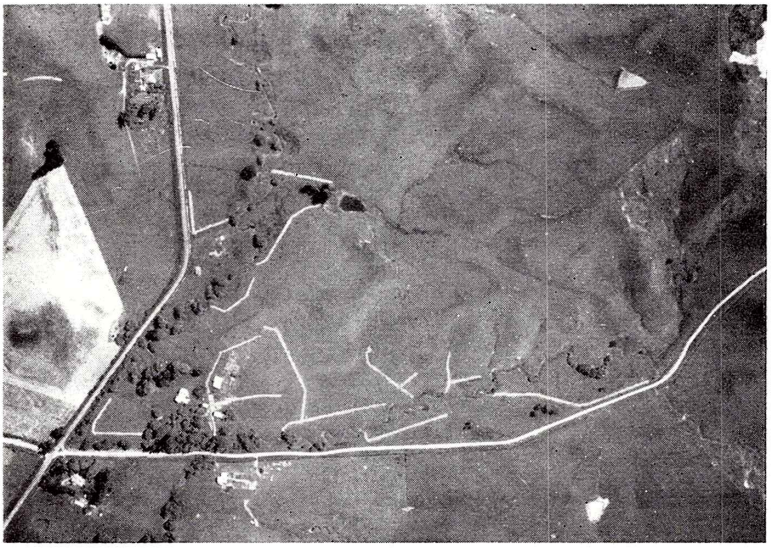

Fig. 2: The difficult problem of recording scattered tile lines spread over a large area in rolling clay country, as in this example, is readily overcome by aerial photography.

such determinations is bound up with the season of the year in which the photos are taken. Plant cover and soil moisture conditions also play an important part.

Photo interpretation for farm drainage purposes, involving considerations of soils, topography, and farm lay-out, must be coupled with a considerable background of field experience on the part of the interpreter. This is an essential qualification for the extraction and collation of worthwhile information from air-photos.

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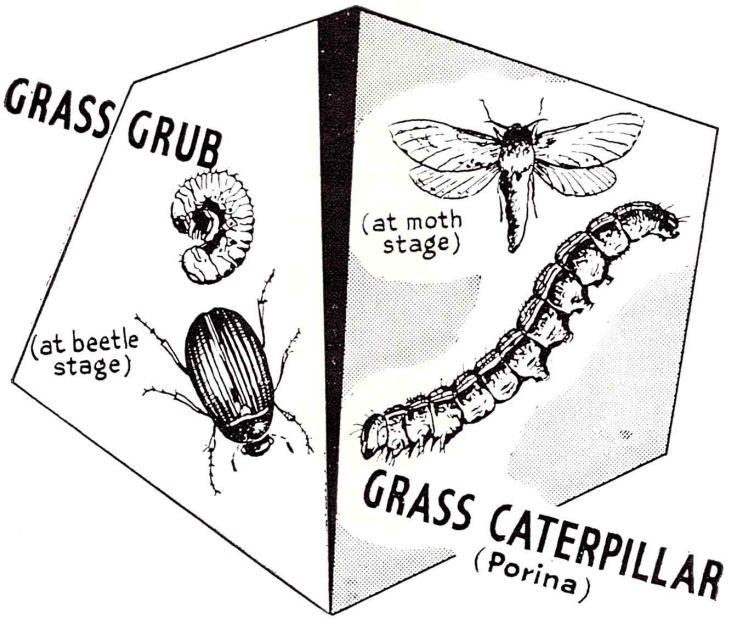

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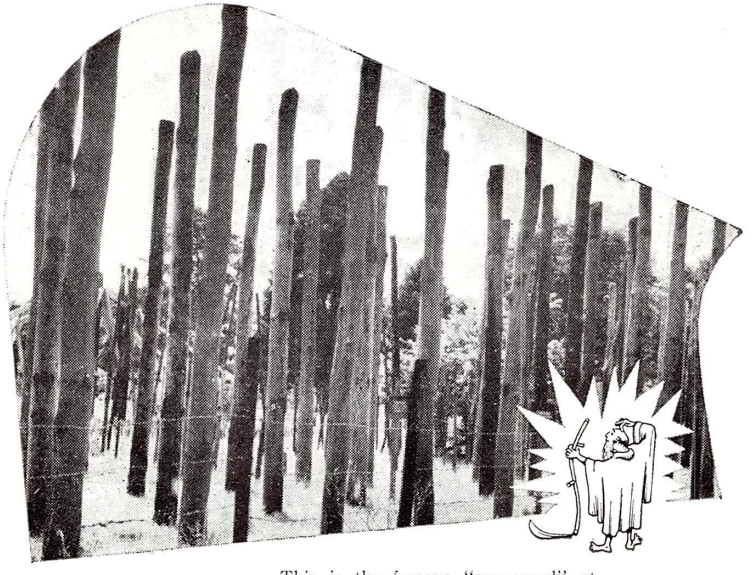

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H21/59

PASTURE ESTABLISHMENT AND MANAGEMENT

R. W. BROUGHAM*

THE MATERIALS AND RECOMMENDATIONS presented in this paper have been drawn from a number of published articles in which results have been presented of work carried out at the Grasslands Division by a number of workers. They have been drawn together in an attempt to outline the pattern of development of seedlings in new-sown pastures and to illustrate what is likely to happen when a particular practice is employed in establishing pastures.

For this reason, it is not proposed to give blanket recommendations for seed mixtures to be used on the farm. Such recommendations may have many shortcomings, as completely different seed mixtures may be necessary on contiguous paddocks on the same farm. As examples, on dry areas where summer feed is important, cocksfoot and red clover dominant mixtures may be necessary, whereas on wetter areas the more standard ryegrass and white clover dominant mixture may be sufficient. Similarly, in sandy areas, where availability of water is of importance in determining the dominance of species, the need for strawberry clover where the water-table is high and subterranean clover where the water-table is low, with white clover filling the intermediary areas, may necessitate patch sowing by hand to avoid seed wastage and obtain successful establishment.

It is well known that species sown in pasture mixtures emerge and develop at different rates from sowing. This development determines the competitive capacity or aggressiveness of the seedlings in relation to the species sown and is dependent on factors such as seed size or the amount of storage tissue in the seeds, availability of water, the temperature of the soil, soil fertility, and so on. Of more importance to the farmer, the aggressiveness of a species from sowing determines the pattern of development of the pasture and markedly influences what should be done to obtain the successful establishment of all sown species.

Table 1 gives a list of some of the more common pasture species used in New Zealand in order of seedling aggressiveness. The list would apply to autumn sowings on soils of medium to high fertility.

**Grasslands Division, D.S.I.R., Palmerston North.*

TABLE 1: Order of Seedling Aggressiveness of Some of the Common Pasture Species in Establishing Pastures.

Cereal cover crops—barley, oats, ryecorn, etc.
Prairie grass
Italian ryegrass
Short-rotation ryegrass
Perennial ryegrass
Cocksfoot
Timothy
Browntop
Red clover
White clover
Lotus spp.

A list such as that shown in Table 1 is a generalized one, but it does serve to illustrate the aggressiveness of the grass species in autumn sowings and the very slow development of the clover species. It can be seen that the main problem in pasture establishment in localities similar in climate and soil type to the Manawatu is one of successfully establishing the sown clover species. This applies particularly to white clover, because of its very desirable capacity for fixing nitrogen when established. Also associated with this is the need to reduce aggressiveness of sown grass species.

The problem can probably best be illustrated by following the development of a pasture mixture from sowing to the time of successful establishment. The example used is a mixture in which barley as a cover crop is autumn sown with short-rotation ryegrass, perennial ryegrass, cocksfoot, and red and white clover.

The first species to emerge from an autumn sowing of this mixture is barley and its early growth is very rapid. The development of the other species is short-rotation ryegrass, perennial ryegrass, cocksfoot, and the clovers, in that order. However, as each species emerges from the soil and begins to grow, it in turn affects the development of the other sown species by overshading. By the time the barley plants have reached a height of 6 to 9 in., and the grass species 3 to 4 in., the clover seedlings, which have developed to about 1 in. in height, are subjected to a very low light intensity. At such low light levels, photosynthesis in the clover seedlings is severely restricted and, because the plants are respiring, very little increase in the growth of seedlings results. Unless the top canopy of barley and grass is removed by grazing

so that light is allowed to penetrate down to the clover seedlings, photosynthesis may be completely inhibited and death of clover plants occur. Where no effort is made to prevent this intense seedling competition for light, widespread death of clover plants results. This loss of clover plants results in a very yellowish-looking, nitrogen-starved pasture in the following spring. The effect is accentuated by the fact that any nitrogen that was in the soil at ploughing, or has been released by soil bacteria from the organic matter after ploughing, is rapidly used by the grass plants during the winter, or is leached from the soil by rain. Grass growth is then severely restricted and remains poor until any surviving clover plants or volunteer clover seedlings from buried seeds develop to such an extent that nitrogen fixation begins and vigorous grass growth recommences.

The intensity of competition for light between the species of a pasture mixture similar to that above is shown diagrammatically in Fig. 1. The figure shows the amount of light, as a percentage of daylight, that penetrated down the herbage canopy to various heights above ground-level.

The results are obvious and illustrate vividly the intense competition for light that goes on between the component species of the mixture within the body of the pasture.

It should be evident, then, that some effort is required by the farmer to reduce to a minimum by various sowing and management practices the intense interspecies competition for light that occurs in new-sown pastures. There are a number of ways in which this can be achieved, but, in all cases, the practices are dependent on the farmer's objectives in establishment. The main aim should be to establish successfully all sown species as quickly as possible. However, in so many cases, the emphasis in establishment is on the production of early feed to the detriment of the sown species and particularly the clovers. It is this outlook of the farmer that can account for many of the sowing failures seen in pastoral areas in New Zealand and particularly in the North Island. So often all that is required to overcome the problem is a different outlook towards establishment.

As an example, it is well known that, for most pasture species, and particularly those with an erect growth habit such as the ryegrasses, cocksfoot, or timothy, higher yields of herbage or feed are usually obtained by increasing the spelling interval between grazings. This also applies to new-sown pastures, as is shown in Table 2 for a new-sown pasture of short-rotation ryegrass, red and white clover. The pasture was sown in early April, the

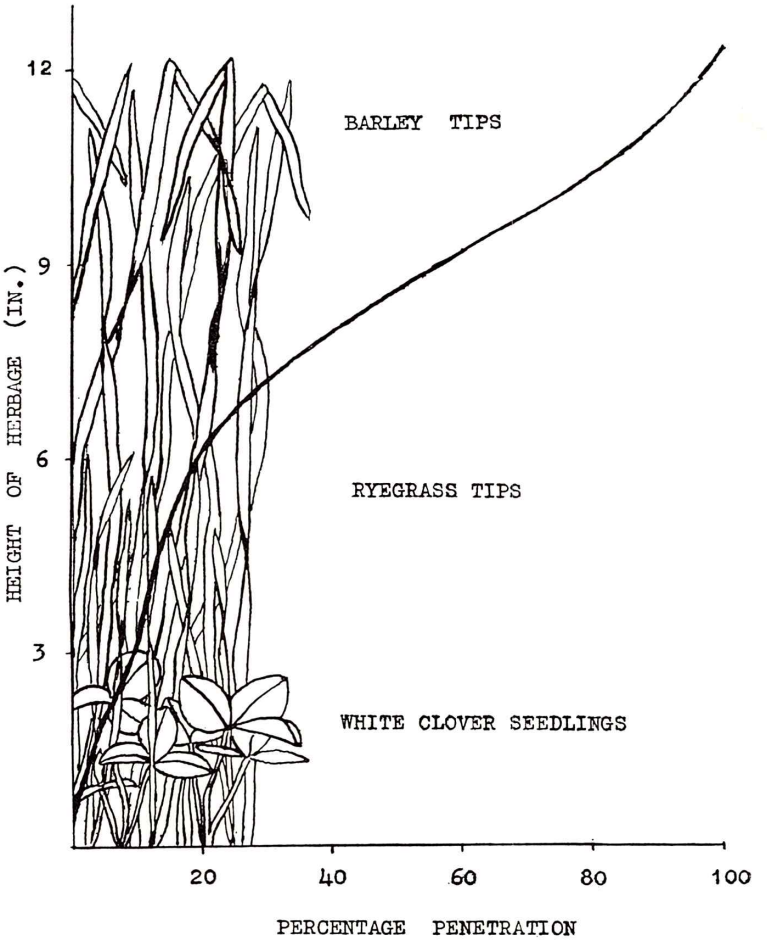

Fig. 1: The percentage of light penetrating to different heights above ground-level in an establishing pasture of short-rotation ryegrass and white clover with barley as a cover crop.

grass species at 40 lb per acre and red and white clover at 4 lb and 3 lb per acre respectively. The table shows the total yields of herbage obtained from this pasture during the first six months of growth from two different systems of management.

If the amount of food produced from the pasture was the only criterion of successful establishment, obviously the most favourable early management would be one of allowing the pasture to

TABLE 2: Total Herbage Yields of a Short-rotation Ryegrass, Red and White Clover Pasture during the First Six Months of Growth under Two Systems of Management.

Grazing height (in.)	*Number of grazings*	*Total yield (lb grass)*
3	5	2,900
9	2	4,000

reach 9 in. before grazing. However, as has previously been shown, intense interspecies competition for light occurs under this system of management and death of clover seedlings results. This is demonstrated in Table 3, where the number of white clover plants surviving in the two pastures in late August is shown.

TABLE 3: Number of Surviving White Clover Plants per sq.ft. of Pasture.

Grazing height (in.)	*Number of plants*
3	20
9	13

From both tables, it can be seen that, although approximately 40 per cent. more feed was obtained from the pasture grazed at 9 in., establishment of clovers was poor. Nearly 50 per cent. more clover plants survived in the pasture grazed at 3 in., and in addition each plant was more vigorous and more advanced in development. Figure 2 illustrates one of the reasons for the better clover establishment under the 3 in. system of management. It shows the percentage of light received by clover seedlings in two different pastures. In one of these, the height of ryegrass herbage was 3 to 4 in. above ground-level, and in the other, 6 to 7 in. above ground-level. In the first pasture, the clover seedlings were receiving 20 to 25 per cent. of the total available light, whereas in the taller pasture they were receiving less than 5 per cent. In the latter pasture, this amount of light is lower than that required for active photosynthesis.

The above example illustrates how the farmer can control the early aggressiveness of the grass species by ensuring that the growth of the pasture is never allowed to reach a height such that the light received by the clover seedlings is low.

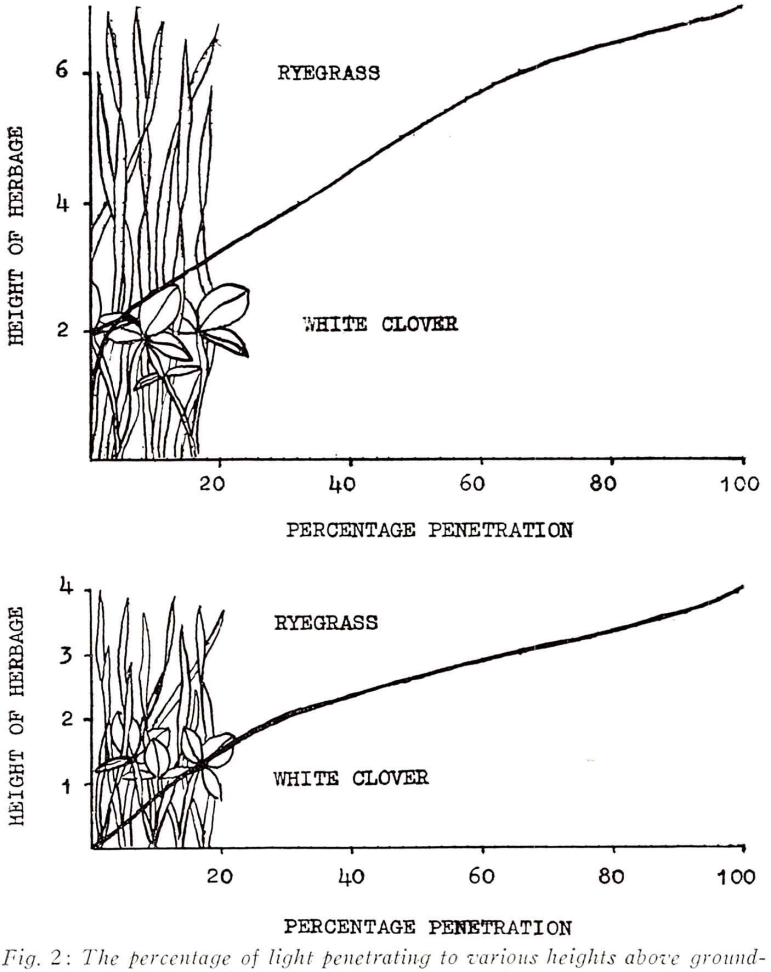

Fig. 2: The percentage of light penetrating to various heights above ground-level in two establishing pastures where the height of ryegrass leaves is different.

Another method available to the farmer of combating the early aggressiveness of the grasses is in compounding the seeds mixture and adjusting sowing rates with regard to seedling aggressiveness.

Under sheep-farm conditions, a grass seeding rate of approximately 40 lb per acre is often used. The purpose of this sowing rate is to obtain a quick ground cover and to combat weed development. By trial and error over many years of farming experience

and with the machinery then available, this sowing rate was established as suitable for the above purposes. However, where short-rotation ryegrass is the dominant component of pasture mixtures, it is sometimes advisable to reduce the seeding rate of this species.

It has been shown at the Grasslands Division that the pattern of development of a 20 lb per acre autumn sowing of short-rotation ryegrass is very similar to that of a 40 lb per acre autumn sowing of perennial ryegrass during the first six months of growth. Short-rotation ryegrass, because of its closer relationship to Italian ryegrass, has the ability to grow much more rapidly than perennial ryegrass under the temperature conditions that prevail during the late autumn and winter. For this reason, it establishes more quickly and competes more strongly with the associated clover plants. A reduction in the number of establishing plants will then assist in reducing the competition between the grasses and clovers for light. Similarly, under wet conditions, where grazings during the late autumn and winter are impracticable because of the heavy pugging that occurs, reduced grass seeding rates will enable the clover plants to compete more favourably with the grass plants under less rigid management. However, for sheep pastures where density of plants is important in herbage production and where early management of the sward is well controlled by grazings, the higher sowing rate of perennial ryegrass might be advisable.

The fertility level at sowing also influences the aggressiveness of the grass species. Under high fertility conditions, because of the high amounts of soil nitrogen available for grass growth, the grass species in the mixture grow rapidly. The establishment of pasture mixtures under these conditions is associated with intense interspecies competition between the developing seedlings. On the other hand, under low fertility conditions, and particularly in soils such as the pumice areas of the Rotorua-Taupo district, where the available nitrogen is low, grass growth is restricted. In these conditions, the clover seedlings flourish and soon dominate the pasture. The grasses in the mixture are then overshaded by the clovers and do not contribute appreciably to herbage yields until the clover plants have developed to a stage where nitrogen fixation and release occur in the soil. Under high fertility conditions, this latter pattern of growth can be approached following an intensive cropping programme where saleable products are grown or crops are fed off the area on which they were grown. In this way, nitrogen levels are reduced and a more suc-

cessful establishment of all species included in the seed mixture may be obtained.

So far, the discussion has been concerned with the general principles of pasture establishment. It has not taken into account particular requirements such as inoculation of clover seed with nitrogen-fixing bacteria, fertilizer requirements at sowing, such as the use of artificial nitrogen to stimulate grass growth, special purpose pastures and their requirements, time of sowing, problem areas, and resowing of unploughable areas. All these factors are of importance in a pasture establishment programme.

Influence of Weeds on Pasture Establishment

In Table 1, a list was shown of species in their order of aggressiveness during autumn establishment. It was drawn up without consideration of the growth of weeds. The order of aggressiveness of the species listed would change markedly if weeds were taken into account (see Table 4).

TABLE 4: Order of Aggressiveness of Species Developing in Establishing Pastures in Weedy Soils.

Regrowth of Old Man Dock
Fathen
Cereals
More weeds
Ryegrasses
More weeds
Cocksfoot
More weeds, etc.
Clovers

The growth of the weeds would depend on locality, but it has been shown at the Grasslands Division that some soils contain a high proportion of buried weed seed. Their ability to germinate rapidly and grow vigorously means that they compete strongly for nutrients, water, and light, often to the detriment of the sown species. The need for weed control by various methods is essential, and these include topping established pastures to prevent seed head formation of weed species, attention to the cleanliness of bought-in hay, chemical weed control, sound cultivating procedures, and intelligent use of stock to clean up weed species.

In conclusion, the use of good quality seed of high germinating capacity, high purity, and trueness to type must be emphasized. Grass and clover strains and species are continually being improved for characters such as winter herbage production, tillering capacity, and many others. These characters are then included in the seed used for growing the nucleus stock which in turn is used to grow seed crops. These go on to the market as certified seed. By using this seed, the farmer can be sure he is getting the latest model available to him.

DISCUSSION

Q:: *What would be the fate of the clovers in spring sowings?*

A:: Because temperatures are increasing during the spring, clover establishment is less difficult, provided the principles mentioned in the paper are adhered to. However, weed growth is also favoured at this time of the year and often spring sowings are very poor.

Q:: *What is the place of artificial nitrogen in pasture establishment in autumn sowings on peaty soils?*

A:: In areas where available soil nitrogen is low in the early spring, as occurs on many soil types, artificial nitrogen applied in small dressings can be advantageous in promoting grass and clover growth.

Q:: *Does the speaker imply that there is little value in using a cereal cover crop?*

A:: No. However, where difficulty is experienced in controlling the cover crop, such as occurs under wet conditions, it is advisable not to include a cereal in the mixture.

Q:: *Is there any chance of frost damage in closely grazed new pastures?*

A:: In this district I doubt whether frosts are severe enough to cause damage. However, in areas where frosts are severe, such as in the lower part of the South Island, some damage through frost lift may occur.

DR A. STEWART: In the United Kingdom new pastures are rolled in spring to alleviate frost lift damage.

Q:: *At what age does clover start fixing nitrogen?*

A:: I do not know. The beginning of nitrogen fixation in establishing clover plants depends on many factors such as temperatures, amount of air space in the soil, presence or absence of clover nodule bacteria, type of bacteria, and many other factors. Any estimation of the age of clover plants at which fixation begins would need to be considered in relation to these factors.

Q:: *Which is the more aggressive cover crop—barley or rye-corn?*

A:: Barley is a more erect growing plant than rye-corn and because of this may be slightly more aggressive than rye-corn. However, both can cause severe clover plant damage if left ungrazed for long periods.

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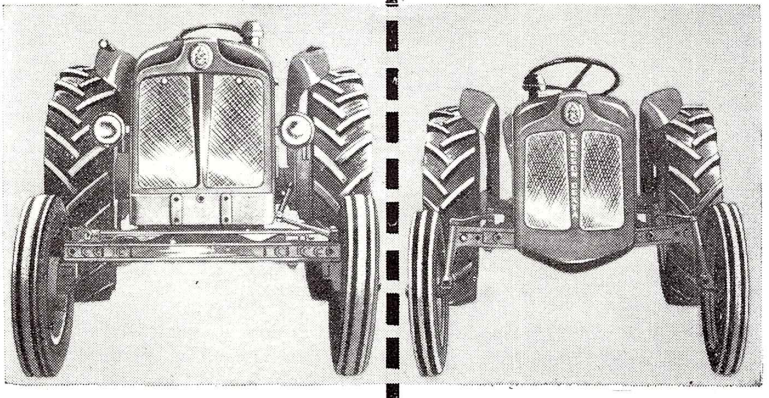

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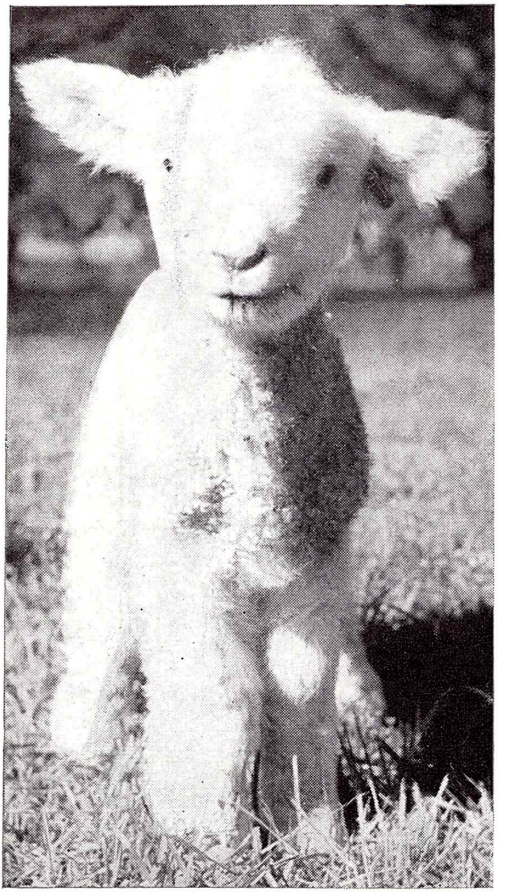

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METHODS OF REDUCING PASTURE ESTABLISHMENT COSTS

M. W. CROSS*

THOUSANDS OF ACRES of farm land are laid down to pasture each year. Tens of thousands of pounds are spent each year to sow them. Subsequently these pastures provide the main source of New Zealand's wealth, and, rightly, no endeavour should be spared to ensure that they will be capable of providing ample and continued food for livestock. But such endeavours must be economic, be practical, and be directed along the right channels.

There are few crops which respond better to correct planting treatment than permanent pasture—and few which can have such a long-term influence on farm productivity. If unchecked from the start, a satisfactory establishment and cover will be assured in the minimum of time. On the other hand, a poor strike, coupled with a preponderance of weeds, may mean that production will never reach the anticipated level.

Despite the relatively satisfactory results obtained from current methods of pasture establishment, it is suggested that in many instances the methods used are wasteful of time and money, and produce results which are far from the ideal. How can improvement be effected?

Wise Selection of the Seed

There is no doubt whatever that the only "cheap" seed is good seed. Three factors decide seed quality. It must be of high purity, germinate freely, and be capable of providing plants of good type.

Before buying the seed, plan a mixture suited to the locality and grazing requirements. If there is any doubt, consult the local Instructor in Agriculture or other competent advisers.

When purchase is made, certified seed should always be specified and the certificates of analyses issued by the Seed Testing Station should be inspected. One of the important details, amongst others, is the date of the certificate found at the bottom left-hand corner. If this is more than six to nine months old, the seed should be submitted to the Seed Testing Station for a further analysis.

**Massey Agricultural College, Palmerston North.*

Regarding germination, the quality of the seed is influenced not only by the final percentage of seeds which germinate, but also how quickly they germinate. If a high interim count with only a slight increase to final count is recorded, this seed will be preferable to one with a low interim count but the same final count, because it is a more vigorous line and will establish more quickly in field conditions. An explanation of the full value of seed testing has already been published in the proceedings of a previous Sheepfarmers' Meeting (*Sheepfarming Annual*, 1957, p. 25) and in the *New Zealand Journal of Agriculture*.

Better Seedbed Preparation

Most farmers are (or should be) aware of the ultimate purpose of tillage, which is, basically, to provide conditions favourable to vigorous crop growth. With this objective in view, no matter what primary cultivation equipment is used—plough, giant discs, or rotary hoe—the end result should be to produce a seedbed which is weed-free, fine, firm, and moist, so that the small seeds of the pasture mixture can be in close contact with the soil particles from the moment they are sown.

Before ploughing, surface cultivation to a depth of 2 to 3 in. with any equipment such as rotary hoe, discs, or cultivator can always be recommended. It is particularly beneficial when going from grass to grass, as this practice hastens decomposition of the old sward, promotes a better burial of surface vegetation, reduces subsequent cultivation to a surprising degree, aids consolidation, and helps considerably in conserving moisture following a spring sowing.

At this stage, it is opportune to emphasize the need for a smoothing operation with some type of leveller before the field is sown. Once sown to pasture, a field cannot be levelled, and the inconvenience and many disadvantages of a rough paddock remain for years to come as tangible evidence of sub-standard preparation.

Another point to remember is that, as sowing time approaches, so depth of cultivation should be decreased. Where weeds are known to be troublesome or abundant, a significant reduction in numbers can be made by two or three light harrowings spaced at five-day intervals. Weed seeds near the surface are germinated, then killed, and, if no further deep cultivations follow to bring up a fresh batch, the sown pasture will be relieved of much competition. If, however, time is pressing and the delay caused by

these weed-killing cultivations unacceptable, recourse can be made to the appropriate chemical spray once the pasture seeds have germinated.

The type of surface prior to sowing will be governed largely by the method of sowing. For some equipment, a rolled surface is required; for others, the rolling or firming can be done at the time of sowing. Adequate consolidation is probably the most vital factor in seedbed preparation, and every effort should be made to achieve the ideal. With pasture seeds, there is seldom any worry about cultivated ground being too firm, provided there is sufficient loose soil to cover the seed.

Reducing the Seeding Rate

Consider the requirements of the seed. If it is to germinate quickly and grow vigorously in its early stages, it must be sown when the ground is moist and warm enough for active growth and must be placed in a favourable position. That position is on firm moist soil, with fertilizer close by, and covered lightly ($\frac{1}{2}$ to $\frac{3}{4}$ in.) with loose soil. It is then in contact with soil moisture, is protected from birds, and, most important of all, is protected from sun and drying winds. If the seed is sown on the surface without cover or on a loose seedbed, and germinates, one day's hot sun and wind can cause a heavy mortality.

Uniform distribution at the rate of 1 lb per acre would result in 50 ryegrass seeds, 50 red clover seeds, or 150 white clover seeds per square yard. A pasture mixture consisting of 20 lb perennial ryegrass, 10 lb short-rotation ryegrass, 3 lb red clover, and 3 lb white clover sown at the rate of 36 lb per acre would provide 2,100 seeds per square yard. Or, to break it down still further, about 233 seeds per square foot.

For a broadcast sowing, allowing a 60 per cent. mortality during germination and establishment (field trials show this to be not excessive), there would be 93 plants per sq.ft, which is still more than will be found on the average established pasture. Place the seed correctly, allow a 30 per cent. mortality (field trials indicate a much lower mortality), and there should be about 163 plants per sq.ft. On this basis, the plants would appear to be very overcrowded, and a heavy thinning-out must result. Could not the initial seeding rate be considerably reduced and the seed sown more precisely to achieve a desirable density? Field trials indicate that this is quite practicable.

In one trial, a pasture mixture sown at 45 lb per acre by a generally approved method (involving three trips over the field) gave an average density of 96 plants per square foot six weeks after sowing. The same mixture sown more precisely at 26 lb per acre with the roller-drill (in a once-over operation) resulted in 108 plants per square foot—and these showed more vigorous growth.

Current trials at Massey College to compare methods of pasture establishment have given the results set out in Table 1.

TABLE 1: Total Number of Plants (Ryegrass and Clover) per sq.ft 14 Days After Sowing and Yield (lb D.M./acre) from the First Cut.

	No. of plants	*Percentage Establishment*	*Yield (71 days)*	*Percentage Weeds*
Sown at 15 lb/acre (= 111 seeds per sq. ft), 24 March, 1959				
Broadcast	44	40	406	19
Roller drill	93	84	511	9
Grain drill in 3½ in. rows	93	84	692	12
Sown at 30 lb/acre (= 197 seeds per sq.ft), 24 March, 1959				
Broadcast	79	40	494	10.5
Roller drill	151	77	1033	7
Grain drill in 3½ in. rows	151	77	1089	4.5

Amongst other things, these results show that the heavy-rate broadcast failed to produce as much as either of the precisely sown light rates. In this trial, the broadcast sowings were made on a chain-harrowed surface (previously rolled), using a drill with coulters and tubes removed and an effective spreader board fitted under the seeders to ensure a uniform distribution across the width of the machine. The plots were then chain harrowed.

Numerous other field trials have all given similar results—namely, that when better methods of sowing are employed, seed rates can be considerably reduced without detriment to the plant population when compared with heavier rates sown broadcast. When using the same method of sowing, a heavy rate will generally give greater production at the first grazing (from the grass component). At the second and subsequent grazings, there is little difference in yields, although with spring sowings the lighter rate

has in some instances yielded more than the heavy rate, largely because of the increased vigour of the clover.

Many farmers consider that a heavy rate of sowing will help to suppress weeds, but this must be directly related to the number of pasture plants establishing and the uniformity of their distribution. In all Massey College field trials the number of plants establishing from a heavy-rate broadcast has failed to equal the establishment from a much lighter rate more precisely sown. Weeds can be controlled by cheaper and more satisfactory means. Precise sowing with banded fertilizer encourages the grass at the expense of the weeds.

Some farmers use high seeding-rates in an endeavour to improve the overall distribution of established plants. Surely this is a high price to pay for a uniform coverage of the field which can be achieved at lower rates sown more precisely.

A further argument against heavy seeding rates of ryegrass is the smothering effect on the slower establishing species. Rates of 1 to 1½ bushels of ryegrass per acre in a mixture can result in severe suppression of cocksfoot, timothy, and white clover. Work on pasture establishment problems at Grasslands Division, D.S.I.R., and at Invermay clearly indicates this effect. In the Massey College trials, some of the heavy-rate sowings gave a pure ryegrass yield at the second grazing, while the light-rate sowings (using the same method) contained 7 to 8 per cent clover. The yield (D.M./acre) was substantially the same.

It seems pointless to include expensive seeds, such as timothy (10s. 6d. lb) and cocksfoot (9s. lb), and then to smother them with 1½ bushels of ryegrass, while the white clover is also so suppressed that it does not play its full part in the pasture till the second season from sowing. The consequent unbalance in the pasture can adversely affect production.

More Precise Methods of Sowing

All through this paper, emphasis has been given to the desirability of more precise methods of sowing, whereby all of the seed and fertilizer is placed together on a firm surface and covered positively with soil. An excellent example of the effect of this placement is afforded by wheel tracks, tyre-treaded marks, and sometimes foot prints on a newly-sown field over which the seed has been broadcast. These marks become very evident in the early stages because of the quicker germination and more vigorous

growth of the plants in them. If the marks are closely investigated, it will be found that they were made immediately before the seed was broadcast. Similar marks made after the seed has been sown have little or no effect.

Precise sowing methods do not necessarily imply specialized machines, although such equipment is available. While it is appreciated that no one method would be universally acceptable nor desirable, it is suggested that at least one of the following methods can be put into practice.

The V-ring Roller Drill

This machine has given consistently good results for the nine years it has been under observation. It comprises a 60° V-ring roller fitted with a fertilizer box, grass seed box, and turnip box, all sowing behind the roller with a light trailing harrow. Machines are now available with 26 in. hollow-cast V-rings (which are recommended), improved lateral distribution, and can be used very satisfactorily for sowing forage crops. Scrapers are fitted as standard equipment and the wide range of change pinions available provides for all likely seed rates.

It is emphasized that the drill works most efficiently if the top 2 in. of the soil is loose, so that the grooving action to the full depth of the rings may be utilized. When soil conditions are rather dry, it is preferable to sow on a freshly harrowed surface so that any dry surface layer is broken up. The wedging action and weight of the implement provide adequate consolidation, and all the seed and fertilizer which fall to the bottom of the grooves are covered to a uniform depth by the trailing light chain harrow.

The V-roller is well suited to normal cultivation work, and to increase its versatility further provision should be made for lifting the seed and fertilizer boxes off the roller-drill and placing them on to a standard drill frame so that farmers could make greater use of this expensive item, thus reducing capital costs.

Drilling in 3½ in. Rows

Farmers who already own a hoe coulter drill can, for a very small cost—approximately 30s. per coulter—convert these into a very satisfactory machine for sowing down pastures on land free from surface trash. There are two methods. First, a split or divided coulter tip can be attached in place of the normal hoe tip. Secondly, subsidiary coulters can be attached offset 3½ in. from

the standard coulters. The divided coulter tip is probably the most generally useful, and sowings following its use have been most satisfactory. It was originally designed for sowing down on summer fallowed ground and should be used on a rolled surface. Heavy harrows—*e.g.*, tine harrows upside down—must be trailed behind to smooth out the ridges formed by the coulters. Seed rates—particularly the ryegrass component—should not be high, because of the excellent establishment percentages recorded and the likelihood of smothering the slower growing species.

Wherever this method has been used under conditions suitable for its employment, results have invariably been good. Consolidation must be achieved before sowing, and blockages are likely to occur in trashy ground.

Cambridge Roller and Attachments

On clay soils, when adequate moisture is present, the standard Cambridge roller in good condition, with grassbox attached, has given satisfactory results. To improve its performance and to reduce working time and cost, a topdresser should be attached behind the roller and a light chain harrow trailed behind the topdresser.

Although the grooving action and consolidation of the Cambridge roller are not as good as the V-roller, a large proportion of the seed is placed, with fertilizer, in the bottom of the grooves and is covered with soil. It is significant that little seed establishes between the roller grooves unless moisture conditions are ideal—hence a roller with worn rings is not satisfactory. If a new roller is being purchased, the hollow-cast 26 in. V-ring should be considered.

If a coulter drill is available, this can be attached to the roller and harrows trailed behind. The coulters should be either removed or wound up clear of the ground, the tubes removed, and an effective spreader board fitted underneath the seed and fertilizer boxes to ensure an even distribution across the width of the machine.

Finally, if only a topdresser is available, together with chain harrows, they can be hitched behind the roller and the mixed seed and fertilizer sown together. It is not recommended that this mixture be left for more than an hour or two, as damage to the seed may occur—small mixes, made as required, are preferable.

The practice of ganging up implements, particularly the combinations suggested above—none of which increases power requirements very much—has much to commend it.

Time and cost are reduced by fewer trips over the field.

By rolling and sowing in one operation, the seed falls into the freshly made grooves and will rest on the firm ground. If, however, the field has been rolled for some hours prior to broadcasting in a separate operation, the grooves will be partly filled with loose soil. The seed then falls on to this loose soil and if no rain comes to consolidate the soil around the seed, there is a danger of it being killed by drying winds after it has germinated.

These practical methods have been recommended on account of their reliability, which is due to the precise placement of most of the seed in the most favourable position for germination and establishment. With such treatment, assuming that adequate land preparation has preceded sowing, and suitable grazing practices follow, there seems to be no valid reason why seed rates of 15 to 20 lb per acre should not be sufficient to provide the foundation of a high-producing sward.

Overdrilling Crop Stubbles

Once again, attention should be drawn to the very considerable savings which can be made by overdrilling crop stubbles immediately the paddock becomes available. This practice has proved very successful over the past four to five years for autumn or spring sowings, on flat or even steep ground.

The seed and fertilizer are sown through a drill using disc coulters for most conditions, although hoe-coulters fitted with grassland overdrilling tips are satisfactory where there is insufficient trash to cause blockages. No surface cultivation whatever is necessary, nor is it desirable, because it induces weed growth. Some type of chain harrow or a separate trailing chain on each coulter should be used to cover the seed. Drilling should be done in two directions at about a 30° to 40° angle and half of the seed sown in each direction. Seed rates—particularly of the ryegrass—should not be high because of the possible smothering effect, and grazing management must be intelligent.

One prerequisite of this method of sowing is that the final levelling or smoothing of the field must be done before the crop is sown in the spring. Another is that the operation should be carried out as soon as the field becomes available. After a cereal crop, the straw should be burnt and overdrilling done immedi-

ately. In no circumstances allow the drill coulters to penetrate deeper than is necessary to provide cover for the seed—usually about $\frac{1}{2}$ to $\frac{3}{4}$ in.

Advantages of Overdrilling Crop Stubble

(1) It is cheap. All cultivation costs are eliminated.
(2) Consolidation of the seedbed is good—it remains undisturbed.
(3) Moisture is conserved in autumn sowing.
(4) Earlier sowing, with its many advantages, is possible in the spring.
(5) Annual weeds do not present any problem.
(6) The field is back into production much quicker than with an arable sowing.
(7) More vigorous growth results from placing the seed in the fertile top layer instead of dissipating this layer by cultivation.
(8) Erosion control is achieved during the establishment period.

Some farmers have been using this method of pasture establishment for four seasons now and have expressed full satisfaction with the results they have achieved. It is high time that more farmers should be cutting their establishment costs.

References

Sheepfarming Annual, 1956: Modifications to Present-day Tillage Practices, p. 96.
Sheepfarming Annual, 1957: Overdrilling Fed-off Forage Crops, p. 195.

DISCUSSION

Q:: *How does the stability of the new V-roller drill compare with that of the old solid ring type on hill country?*
A:: Current models—particularly if the 26 in. hollow-cast V-ring is fitted —are quite satisfactory. Weight has been reduced by approximately a quarter without impairing efficiency. On very steep sidlings there will always be a certain amount of side slip.

Q:: *What does the speaker think of broadcasting the seed and then running a mob of sheep over the paddock?*
A:: Excellent—if the ground is so steep that more precise methods of sowing cannot be employed.

Q:: *In overdrilling chounoellier stubble in August is there a danger of sowing the grass seed too early?*
A:: The seed must be sown early so that it can establish ahead of weeds and volunteer grasses. Late sowings will not be as successful. In this locality August sowings have been satisfactory especially if they have been done during a short spell of fine weather.

Q:: *When overdrilling choumoellier stubble in August on steep ground, will the same result be obtained by increasing the seeding rate as by going over the ground twice at 30° angle?*
A:: No—It is better to make two separate trips. If a 30° angle is impracticable, any other angle is preferable to a single trip at a heavier rate.
Q:: *Am I right in assuming that New Zealand farmers put too much ryegrass in their seed mixtures?*
A:: Yes—Because so much of it is wasted by inefficient sowing methods. If a good strike results, ryegrass (particularly short-rotation ryegrass) can smother the slower growing species. In our trials perennial ryegrass and white clover were the only seeds sown.
Q:: *On a well-prepared seedbed, has the seed box in front of the roller been tried?*
A:: Many times, and the results have been similar to those for broadcast sowings quoted in this paper. There is no precise placement or coverage of the seed by this method.
A MEMBER:: The V-type roller drill does not appear to be efficient on sidlings. Also, where it is necessary to back off, the attached harrows are a nuisance.
A:: In view of the improved performance resulting from this method of sowing, the disadvantage of trailing harrows is of minor consequence. I agree that the roller drill may not be completely satisfactory for very steep sidlings, but such land forms a very small part of the total acreage annually sown to pasture. Precise methods of sowing could well be used on 90 per cent. of the area sown.

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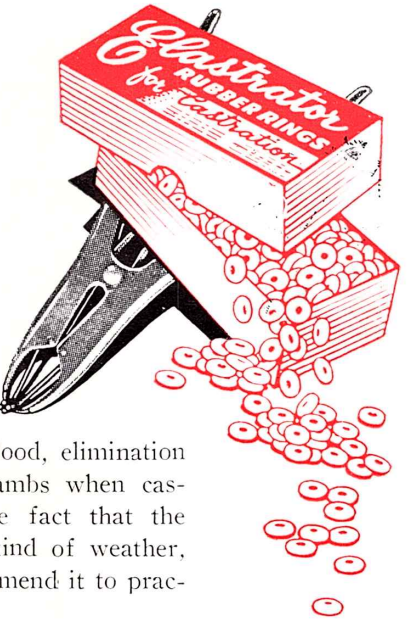

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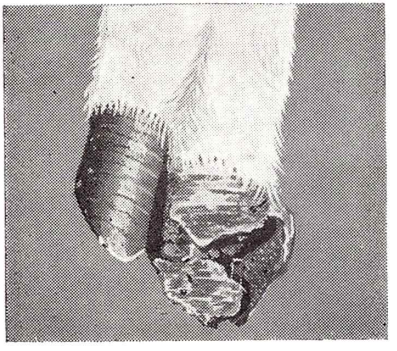

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TOPDRESS THE HILLS OR . . . . ?

SIR BRUCE LEVY*

THE TITLE OF THIS PAPER offers many interesting possibilities. These may be mere statements of fact or they may point to a moral that could threaten the very freedom of individual ownership of land.

Farmers must topdress the hills or assuredly they will sooner or later be farming a turf dominated by tough, hardy, low-producing, and low-palatable grasses and clovers such as *Danthonia semiannularis, Danthonia pilosa,* stunted browntop, sweet vernal, stunted Yorkshire fog, baygrass, hairgrass, Chewings fescue, ratstail, stunted paspalum (in the north), with a few small clovers, mainly annuals, *i.e.*, suckling clover, clustered clover, striated clover, haresfoot trefoil, *Lotus hispidus,* stunted subterranean clover and stunted *Lotus major.* Flat weeds will abound and on the shady slopes there will be much moss. Such a turf will have a carrying capacity of 1½ to 2 dry sheep per acre or their equivalent in store cattle. The presence of small flats, low

**Fitzherbert Avenue, Palmerston North.*

foothills, valley bottoms, and stock camps may improve the position somewhat, but research workers now know sufficient about vegetation behaviour to be certain that turfs adjust themselves to become stable or fixed according to the environment provided for them.

The natural environment of the hills is generally hard and poor once the fleeting fertility of the forest burn is depleted. Soil fertility is by far the most important factor influencing the movement and adjustments in the plant cover, and the only possible hope of influencing the development of a better, higher producing turf of the more valuable species is through soil fertility build-up and the trigger to that build-up is phosphate.

Changes in Plant Cover on Hill Country

In all plant movements, grass is a poor competitor to forest. If the climate is too hard for forest, tussock grassland results that will exist for thousands of years as a stable association. However, where farmers are dealing with the conversion of forest to grassland, grass has no hope of survival unless it is mechanically aided by grazing and browsing animals or by liberal use of the slash-hook and fire. Topdressing the deforested hills is, therefore, necessary or farmers must be prepared to abandon millions of acres of hill country to manuka, gorse, blackberry, tauhinu, fern, and developmental trees that are precursors to forest. One and a half to two dry sheep per acre or its equivalent in store cattle do not provide the mechanical mouth and hoof power to weight the balance in favour of grass—the secondary growth must win. Further, 1½ to 2 dry sheep per acre provide insufficient residues (dung and urine) to influence and improve soil fertility upon which all potential and sustained production depends.

Again, topdressing in the hills is necessary, for the time is fast approaching when the full development of the hills must be essential for New Zealand's continued prosperity and standard of life. True, much of the lowland ploughable and discable country is still in a relatively low state of production, but the next big upward surge in the pastoral industry must rest on the improvement of the unploughable hills. There, as on the flats, the two basic essentials are topdressing and a higher density of stock per acre under manageable control.

There are few spots on the earth's surface where stock can be carried all the year round on grass and in numbers per acre great enough to return residues sufficient to grow the next crop of grass. Older research workers know what most of the country

was like prior to topdressing and when stock numbers per acre were small. It was only by ploughing, cropping, and resowing to grass that some semblance to high per-acre production was possible, and it was only while the virgin forest litter and ash remained on the hills that a relatively high per-acre production was reached. Permanent grass on most of the lowlands was low producing. Permanent grass on the hills, once the forest-built fertility was depleted, was also low producing. Everywhere the application of mineral topdressings—phosphate, lime, potash, and later molybdenum—gave the stimulus to greater herbage production, at first mainly through the clovers. This led to a higher concentration of stock per acre and the manufacture and return to the land of readily available plant nutrients. This marriage of greater herbage production by topdressing and fully utilized by a greater number of grazing animals per acre, together with New Zealand's temperate, equitable climate is basic to its grassland development.

Full Utilization of Herbage

It must be stressed that full utilization of all herbage produced, by *in situ*-fed animals, is the crux of the situation. Grown feed not utilized by grazing, or cut for hay, dried grass or silage, or just left uneaten in the field, militates against pasture development. In Britain there are some fields cut eight times for dried grass and fertilized with up to 1 ton per acre of mineral and nitrogenous fertilizers, but the resultant sward could hardly be regarded as a pasture sward. New Zealand is fortunate that stock can eat most of the pasture crop *in situ* to give stock residues that become sufficient when six to eight ewes per acre plus some cattle, or one dairy cow per acre, are carried to fertilize the next crop of grass. At three to four ewes per acre, plus cattle, there is a turn in the tide towards higher permanent pasture production. Some white clover and more and more ryegrass appear, almost miraculously at times, and as numbers approach the four to six ewes per acre less and less of the poorer species and more and more of the ryegrass-white clover appear in the sward. Full utilization by the grazing animal is imperative to this floristic change. The ryegrass-white clover sward demands high soil fertility and it must have the full light of day upon it if it is to continue to tiller and thrive. If farmers want rank, uneaten feed then they should use cocksfoot, timothy, Yorkshire fog, tall fescue, meadow foxtail, and *Poa trivialis*, and such legumes as red clover, lucerne, and *Lotus major*. Even pampas grass will meet their requirement.

At Te Awa Research Station of the Grasslands Division, D.S.I.R., over the past 10 years F. E. T. Suckling maintained three sheep per acre on normal one-and-a-half sheep country by making the sheep eat all that was ever produced under a set-stock grazing. No topdressing was done, nor was an over-sowing of seed, and the paddock improved considerably in botanical composition; the stock camps enlarged and tracks became better defined and better grassed.

This full utilization, by grazing, of all feed produced is fundamental to pasture improvement and high pasture production, dependent on the simple basic fact that feed consumed and digested within 24 hours is back again into the fertility cycle through the dung and urine of stock, whereas if the feed is left to rot back ungrazed, or if it is taken off as hay or silage, it may be twelve months before it is back into the soil fertility cycle. In that time herbage so stored loses much of its nutritive and manurial value.

There is really no reason why permanent pastures on the hills should not equal permanent pastures on the lowlands in production, based on these concepts of soil fertility build-up and on the full utilization by the grazing animal. At Te Awa Mr Suckling has made frame measurements of stock camps and these have exceeded in production any lowland pasture yet measured. Clean, topdress, oversow, fence, and control-graze the hills and farmers will be greatly surprised with what the hills can produce.

The hills, like most of the lowlands, in their initial low state of soil fertility, must have the same initial boost that was given to the lowlands. It has become commonplace in developing lowland pumice, gumlands, and cold clays to give up to ½ ton of phosphate, plus lime at 2 ton per acre on the gumlands and clay soils. It is contended that the full potential of the hill country will not be developed until this amount of phosphate, with or without lime, is applied. Some hills may need potash and molybdenum in addition. Thereafter, as on the lowlands, once the clovers are in good heart and the stock numbers are built up, the normal 2 to 3 cwt annual dressings of phosphate per acre will continue to trigger the cyclic movement and give momentum to the continuous process climaxed by a higher production of readily edible herbage.

Developing the Hill Country

The problem of cleaning the country, over-sowing, fencing, topdressing, and stocking the hill country so that all herbage may be eaten is not an easy one to solve. It is questionable as to how

many farmers can really do it alone and unaided. It is a big business proposition and it must be such to attract brains, brawn, and finance. Confidence is essential. Is it not possible to extend the company principle to the land as now applies in most industrial developments and in most servicing agencies? There must be many millions of pounds invested by farming communities in ventures (Government, industrial, and otherwise) that would be the more advantageously invested in company development into the land.

True, the Crown, through its Lands Department, Department of Agriculture, and Department of Maori Affairs, could turn their efforts to the hills, and, while such movements must inevitably be slow, yet there is much to be said for the State taking control in the initial development over vast areas of hills.

Farmers may be able to circumvent both these possible developments, but they must bring all the technical, scientific, and mechanical aids to bear on this prodigious and essential undertaking. Topdressing the hills is essential, therefore, or farmers risk the sinking of their individuality and losing their personal freedom to farm the hills as big-business concerns, or even as small business concerns. New Zealand is fast approaching an era in its national economy where land must not, and dare not, become the bottleneck in increased production of raw farming materials. One has only to visit the countryside, the towns and larger cities to see the billions of pounds invested in dairy factories, meat works, wool stores, freezing stores, fertilizer works, farm machinery, seed and produce merchants, stock and station agencies, harbour facilities, ships and other services to the land. One has only to contemplate the vast expansion of secondary industries dependent on imports financed by primary products sold overseas to realize all these interests just cannot afford the land, or condone the land, becoming the limiting factor in their progress and prosperity.

Topdressing the hills is essential, or these will surely become a bottleneck to New Zealand's raising its economy and prosperity.

Farming today is not a question of a farmer's own pair of hands, however willing they may be. It is a question of using and exploiting to full advantage the canned labour of many individual pairs of hands not resident on the farm. It is not so long ago when phosphate was applied to the hills by the literal sweat of farmers and pack-horses and often of the women folk who led those pack-horses. Today aircraft has put an entirely different

complexion on the problem of hill country topdressing, and continued topdressing is necessary if the valuable service built up over the pioneering years by daredevil pilots of the aerial topdressing companies and the Civil Aviation Authority is not to be lost.

There are other aspects, of course, in topdressing country other than the mere increase of herbage to carry more stock per acre. Those stock must be thrifty and there must be a suitable mineral-nitrogen balance to effect this state of thrift. Lime, cobalt, sulphur, copper, iron, and the correct balance of molybdenum and copper are aspects of topdressing needing much research, but to decry mineral topdressing on the grounds they are inorganic, artificial fertilizers and so, *per se*, are injurious to stock, is doing the farming industry a great disservice and encouraging deterioration of the hills.

Today, it is a far cry from the low per-acre stocking density of low milk yielding or of store-conditioned animals scrounging here and there for a morsel to eat, to the present-day picture of high per-acre stocking densities of satisfied, high producing healthy herds of fat cattle and ewes and lambs that literally cover the countryside. Good grazing management and better strains of pasture plants are playing a big part in this development, but the trigger that initiated the development and which keeps the development alive and flourishing is topdressing with mineral fertilizers. Topdressing the hills, watching all the time for minor mineral deficiencies, will continue to provide the high stock density of ewes and lambs and beef cattle, plus the dry stock, unseen and unparalleled anywhere else in the world.

Farmers should continue to topdress the hills and stop complaining about income tax and death duties. The mere fact that these taxes are high proclaims their prosperity. It will be a sad day for the country, and for everyone in it, should the farmers' lot not be a highly prosperous one. It does not matter one whit who first receives and handles that primary wealth. Its re-distribution is the essential thing and the farmer in New Zealand is not a hoarder.

It must be remembered today that a great number of services contribute to farm production, and most of these extract their pound of flesh. The New Zealand farm income all told must approximate £300,000,000, of which some £250,000,000 earns overseas exchange that provides for imports. (The provisional figures for 1957-58 are somewhat lower at £293,900,000 and £236,782,000 respectively.) Were it not for the fact that there were expenses,

services to the land and its produce to be met, the 100,000 landowners today would indeed be wealthy. Even so, there is no doubt that a fair amount is left in the kitty and this is a fair target for income tax and death duties. The State has spent millions in servicing the land and the writer, one of its servants, spent over 40 years in the farmers' service and perhaps the work of myself and my research team at Grasslands put farmers in the way of earning added millions more easily than they have ever been able to do so before.

Dr G. A. Currie, Vice-Chancellor of the University of New Zealand, has stated recently that the two most valuable attributes of this country are grass and brains. Grass, elaborated into animal products, is the mainstay of New Zealand's economic existence and standard of life. It would be a reflection upon the brains of this country if there was indifference or neglect towards the production of more grass and its efficient elaboration into animal products. The best brains of the country should be directed from the political, financial, research, educational and extension, and servicing fields to provide facilities, and lastly, and by no means least, in the practical application of these to the land with the express purpose of growing more grass.

Finally, no progress on the hills is possible without the hill country farmer. Theirs is no easy task, but there are some not doing justice to their ownership of land.

There is no more exhilarating sight than to see hills well grassed, clean of rubbish to the skyline and boundary fence lines, studded with sheep and cattle happily doing their part to control rubbish and to convert the green grass into valuable animal products and fertilizer residues. The aircraft and its intrepid operator have made the farmer's task of topdressing the hills possible and practicable. Fertilizer companies have extended their plant and have increased their output. New fertilizer works have been built to provide the materials economically, close at hand. It would be a national calamity if farmers, the channels for the utilization of this and other services, failed to exploit these facilities to the full. In the final analysis all depends on the farmers and as they value their individual ownership of land above all else they must not fail. Topdress and stock the hills or there can be little or no progress and if this is not done there will assuredly be much more deterioration and a declining, devastating hill country morale. The forest will again triumph. Contrast this with the inherent potentialities of the hills if services such as have been mentioned can be rendered unto them.

It is, of course, not enough to employ aircraft operators to apply phosphates to the hills and to expect miracles. Secondary growths must be cleared from the hills; secondary burns must be suitably sown and weak turfs oversown with good clovers. The hills must be adequately fenced to work the country with cattle and sheep; the ecological balance in favour of grass can be established and maintained only as a result of that working and the improved cover of grasses and clovers to entice all-over grazing.

The provision of access by all-weather roads, of schools and social amenities, and of a good home with modern conveniences are all part of the development, but unless farmers make the growing of grass on the hills their main concern, the home and its establishment and its amenities, good roads and social amenities, good fences, etc., will go for nought in the winning of the hills.

Above all, hill country farming must be kept on a big business basis with an actual labour force, with accent on youth rather than on old age. There is a big place for big operators, for company operators or partnership operators where finance may be encouraged and where staff movements are possible.

Perhaps this is being a little hard on the brave individual and his wife who have in the past gone into the back hill country and made good. Perhaps the major state of the hill country today is due to these ardent pioneers. If finance today would contact and support this pioneering spirit and love of the big open spaces, and use it to place all essential facilities in the hands of these two venturers then going forth into the hills can be contemplated with all the confidence in the world.

The plea is for a more organized attack on the more difficult hill country and to ensure against failure, broken hearts and deterioration through lack of financial support to provide the real triers, individual, company, or partnership with the all-over finance to apply the essentials for development.

Had the original pioneers the aircraft and the fertilizer to top-dress the hills, and the knowledge available today, there would be many million more acres clean and producing. Not that those deteriorated hills have gone beyond recall—far from it—but there is represented there an enormous waste of manpower, money, and spirit, largely because the sowings were cheap and nothing whatever was done to maintain the fertility, the productivity, and carrying capacity of the hills in terms of cattle and sheep. Too much was left to Providence. As it is, there are still too many

farmers relying on big acreage and taking from those acres what God gives for nothing. That policy may work in big ranch farming where production is measured in acres to a sheep rather than in sheep per acre, but all New Zealand's deforested hills cannot be ranch-farmed indefinitely. Sooner or later the forest, through a series of secondary growths, will again take charge. Farmers can foil that development if they topdress the hills. They can cover them with high-producing grasses and clovers and stud them with cattle and sheep. These are New Zealand's security measures. Topdress the hills or New Zealand will lose that security.

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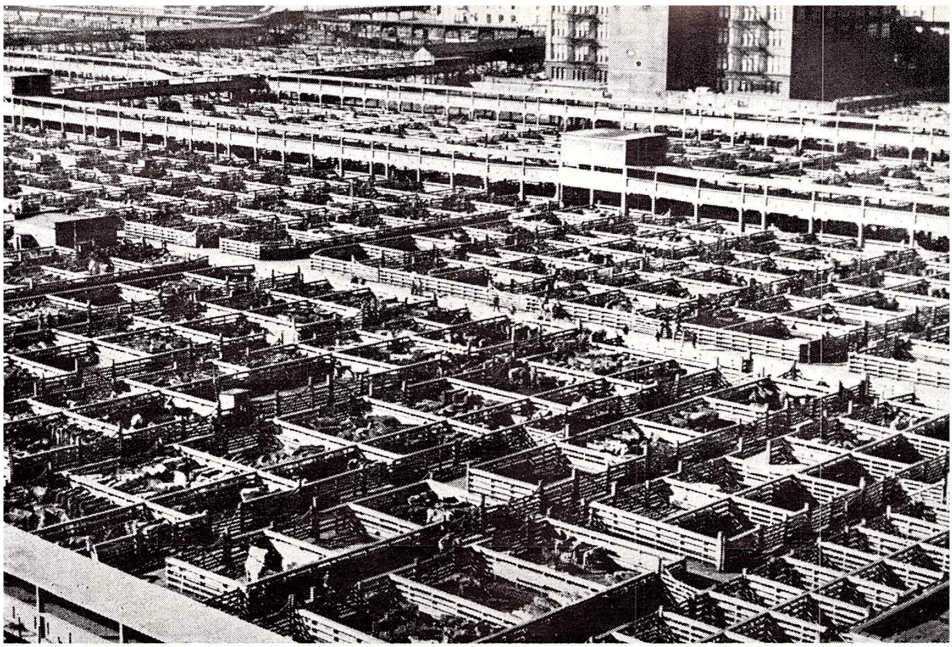


A section of the cattle yards typical of the great meat packing centres of Chicago, St. Louis, and Kansas City.

(U.S.I.S. photo.)

THE AMERICAN LIVESTOCK SITUATION

With Particular Reference to New Zealand's Overseas Markets for Meat

D. E. BRADY*

THE AMERICAN LIVESTOCK SITUATION, while important, is also complicated. The problem is thus one of attempting to obtain perspective. Most New Zealanders are knowledgeable as far as the geography of the United States is concerned. They also know about the vast distances, extremes in temperature, and great diversity existing in agricultural production in the United States.

Perhaps not so well known is that the United States is a country where half of the land is agricultural. Of that which is agricultural, one-third is forested and two-fifths is arable. One-half of the people live in urban areas and one-half in rural. Yet less than one-quarter of those who live in rural areas are farmers. Of those who do farm, half of these (6 per cent. of total population) produce 90 per cent. of the total commercial agricultural output.

**American Embassy, Wellington.*

Furthermore, 80 per cent. of this production is attributable to but 20 per cent. of United States farmers. Thus it is nigh impossible to speak of the typical American farm.

Livestock Basic to American Agriculture

The most important segment of American agriculture is the livestock industry. In 1958, with total cash receipts amounting to $31,000 million (approximately equal to £NZ11,000 million), more than 55 per cent. came from the sale of livestock and livestock products. Table 1 gives a breakdown of the more important items.

TABLE 1: Cash Receipts in 1958 for American Farm Produce.

	Per cent.
Cattle and calves	19.3
Dairy products	15.1
Pigs	10.1
Poultry and eggs	9.8
Feed crops	7.6
Food grains	6.1
Cotton	5.8
Vegetables	5.0
Fruits and nuts	4.6
Government payments	3.3

Forecasting future trends is, at best, a perilous undertaking, however necessary. Full use will therefore be made of recently published information from the United States Department of Agriculture.

Imports and Exports

The United States, which accounted for about 10 per cent. of the world's total imports of meat and meat products during 1957, is the second largest meat importer. With almost 97 million head of cattle, 57 million head of pigs, and 33 million head of sheep, it produced 11.6 million tons of meat last year, or about 28 per cent. of total world production. This was more than twice the production of the U.S.S.R.—the world's second largest meat producer. When United States production dropped by one million tons from 1956 to 1958, it would have taken more than the combined exports of Australia, New Zealand, and Argentina to fill the gap. In fact, the total of the world's trade in meat in

1957—at 5.6 thousand million pounds—amounted to 21 per cent. of United States production that year.

The United States is a large importer of meats and skins and an important exporter of such by-products as animal fats, hides, and variety (offal) meats. It is also the world's largest exporter of mohair, but a large importer of other wool-like specialty hairs and wool. For the current market year (1958–59), it is anticipated that the United States will be the second largest importer of New Zealand wool.

Last year, imports of livestock, meat, hides, skins, and casings amounted to $512 million, and exports of livestock, meat, tallow, lard, casings, hides, and skins amounted to $287 million. Exports were up 9 per cent. over the 1951–55 average, while imports were up 97 per cent. over this same period of time. Thus, from the standpoint of imports, 1958 was quite an unusual year. Actually, imports were up 78 per cent. over the previous year.

Price Level and Imports

There is one point that should be made abundantly clear, as there appears at times to have been some misunderstanding of it. The amount of beef and veal that the United States buys from abroad depends to a substantial degree on the level of United States meat production and prices. In the period from 1951 to 1956, when the United States production rose nearly 50 per cent., imports of beef and cattle declined from 250,000 tons to 110,000 tons (dressed basis). Since 1956, conditions have reversed themselves. Beef and veal output dropped and United States prices have strengthened. This has encouraged expanded imports to meet strong consumer demand. There is every reason to believe that, for the future, the same considerations will apply.

Tables 2 and 3 show the dramatic increases in beef, veal, mutton, and lamb imports for 1958 compared with previous years. They indicate New Zealand's commanding position relative to other countries who are also shipping to this market.

With regard to Table 2, some change may well be anticipated in the position of the South American countries listed, because of restrictions on the importation of meat from countries where foot and mouth disease exists.

Imports of pork are not included in this paper, but there is a classification of somewhat miscellaneous character in which New Zealand has an interest. This is shown in Table 4.

TABLE 2: Beef and Veal: U.S. Imports (product weight basis) by Country of Origin, Average 1951–55, Annual 1956–58.*

Country	*Average* 1951–55 *(mil. lb)*	1956 *(mil. lb)*	1957 *(mil. lb)*	1958 *(mil. lb)*
New Zealand	13.0	4.2	50.0	182.0
Argentina	97.6	72.6	86.3	91.3
Mexico	35.4	6.5	12.9	73.7
Canada	25.3	11.9	47.4	53.2
Ireland	7.1	4.2	6.5	23.7
Australia	1.4	3.1	5.5	16.9
Brazil	2.8	3.1	3.1	10.8
Uruguay	15.6	3.8	11.4	9.5
Paraguay	0.6	1.3	5.8	8.9
Other countries	3.6	1.3	3.5	7.6
TOTALS	202.6	111.9	232.5	477.8

*Includes all beef and veal, fresh, chilled, frozen, boneless, cured, corned, or pickled.

TABLE 3: Mutton and Lamb: U.S. Imports (product weight basis) by Country of Origin, Average 1951–55, Annual 1956–58.

Country	*Average* 1951–55 *('000 lb)*	1956 *('000 lb)*	1957 *('000 lb)*	1958 *('000 lb)*
Australia	2,485	921	1,400	14,577
New Zealand	358	408	1,655	7,013
Canada	609	19	463	1,230
Iceland	490	22	21	1,146
Other countries	124	2	4	10
TOTALS	4,066	1,372	3,543	23,976

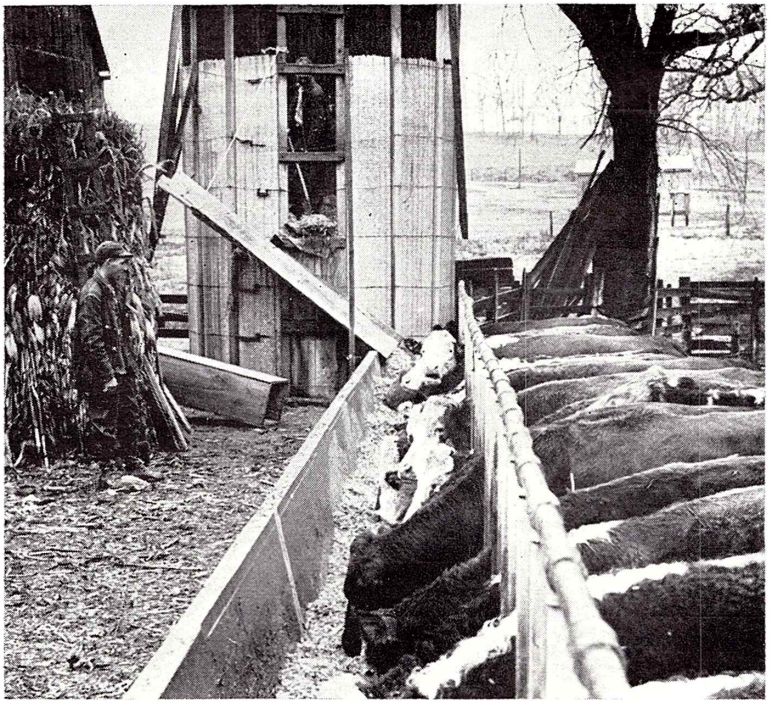
TABLE 4: Other Meat, Canned, Prepared, or Preserved: (product weight basis) by Country of Origin, Average 1952-55, Annual 1956-58.

Country	*Average* 1952–55 *('000 lb)*	1956 *('000 lb)*	1957 *('000 lb)*	1958 *('000 lb)*
Argentina	1,084	4,164	13,134	125,373
Paraguay	—	—	—	5,474
Brazil	—	100	287	2,784
Denmark	359	402	699	2,472
New Zealand	84	58	109	1,670
Mexico	752	43	170	1,292
Australia	206	86	33	787
Canada	799	75	106	416
Other countries	1,028	604	642	1,134
TOTALS	4,312	5,532	15,180	141,402

TABLE 5: Cattle on U.S. Farms, 1 January, by Class, 1955 to Date.

Class	1959 *('000 head)*	1958 *('000 head)*	1957 *('000 head)*	1956 *('000 head)*	1955 *('000 head)*
All milk cattle	32,286	33,413	34,270	34,737	35,361
Beef cattle:					
Cows	25,584	24,287	24,754	25,516	25,659
Heifers	6,822	6,063	6,017	6,238	6,514
Calves	19,755	18,491	18,621	18,979	18,785
Steers	10,213	9,448	9,105	9,560	8,444
Total beef cattle*	64,025	59,937	60,232	62,067	61,231
All cattle	96,851	93,350	94,502	96,804	96,592

*Includes bulls



Feeding out silage to Hereford cattle on a 401-acre farm in Missouri. (U.S.I.S. photo.)

It will be noted in Table 5 that, while total cattle numbers are nearly the same in 1959 as in 1956, there has been a sharp decrease in dairy cattle and a corresponding increase in beef cattle. While fed cattle slaughter has averaged 7 to 9 per cent. above last year, cow slaughter in the first three months of this year was 24 per cent. below last year and the smallest for this period since 1952. This withholding has helped to sustain present beef prices.

Cattle Numbers Pose Risk

All these are the characteristics of a cattle boom—small slaughter in the face of an increased inventory of classes available for slaughter, withholding of cows and calves, and an upswing in prices. It brings with it the sobering prospect of a price decline in the future when marketings catch up with production.

The United States Department of Agriculture has made some projections on numbers and slaughter rate. In Table 6, two alter-

native projections illustrate how much difference the rate of herd expansion could make in beef supplies by 1964. In one projection, the expansion rate would begin to slow after this year. This is probably the slowest rate of expansion that can be expected if no severe drought occurs in the meantime. Such a beef supply would bring a sizeable reduction in prices of beef and of cattle, but it might not be unmanageable, as demand for beef seems still to be growing. But if cattle numbers continue upwards at a fast pace, this would unquestionably result in a demoralized market for cattle. The next 6 to 12 months could be critical ones in the cyclical outlook for cattle.

TABLE 6: Projections of Cattle Numbers and Slaughter at Two Assumed Rates of Expansion, 1959–64 (revised).

	Slowing expansion			*Continued rapid expansion*		
	Number on farms January 1			*Number on farms January 1*		
Year	*All cattle and calves (mil. head)*	*Cows (mil. head)*	*Beef consumed per person (lb)*	*All cattle and calves (mil. head)*	*Cows (mil. head)*	*Beef consumed per person (lb)*
1954	95.7	48.9	80.1	95.7	48.9	80.1
1955	96.6	49.1	82.0	96.6	49.1	82.0
1956	96.8	48.7	85.4	96.8	48.7	85.4
1957	94.5	47.7	84.6	94.5	47.7	84.6
1958	93.4	46.5	80.5	93.4	46.5	80.5
1959	96.9	47.2		96.9	47.2	
Projections						
1959			80.5			80
1960	101.5	48.4	83.7	101.5	48.7	82.6
1961	105.0	50.2	85.0	106.0	51.2	86.3
1962	108.0	52.2	87.1	110.0	53.7	88.8
1963	110.0	54.0	90.0	113.0	56.2	89.7
1964	110.0	55.5	90.0	115.0	58.6	94.5
1965	110.0			115.0		

Returns from Sheep

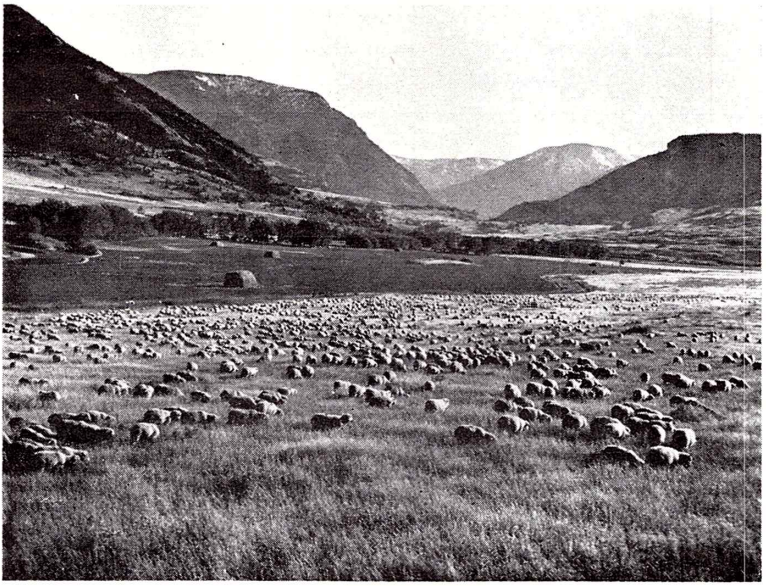
Slaughter of sheep and lambs for the first quarter of 1959, as will be noted in Table 7, has been larger than in 1958, although little different from 1957. Chief cause for disappointment in lamb prices is that they have failed to share in the sizeable cyclical upswing in cattle prices. Usually, lamb prices tag along with prices of cattle.

TABLE 7: Slaughter and Price of Sheep and Lambs, January to June, 1957, to Date (revised).

	Slaughter under Federal inspection			*Price per 100 lb liveweight, choice slaughter lambs at Chicago*		
	1959 ('000 *head*)	1958 ('000 *head*)	1957 ('000 *head*)	1959 (£NZ)	1958 (£NZ)	1957* (£NZ)
January	1,322	1,061	1,333	6.91	8.55	7.37
February	1,080	940	1,091	6.95	8.36	7.44
March	1,143	1,000	1,011	7.34	8.35	8.42
April		1,149	1,061	7.71	7.86	8.67
May		1,122	1,133		7.59†	—
June		1,042	1,044		8.94‡	8.33

*Choice and prime †Shorn lambs ‡Spring lambs

Lower prices for wool have contributed to lower lamb prices. Yet, except for the effect of wool prices, the lower prices for lambs must be ascribed more to the erratic character of the lamb market than to any particular factors. Production of sheep in the United States is small compared with production of other meat animals. Yearly lamb output is merely 3 per cent. of total meat output. In many areas, volume of production is too small, or slaughter buyers too few, to establish as stable a marketing system as exists for cattle and pigs. Further, many sheep and lambs are sold by advance contract. Contract selling is not necessarily to the disadvantage of producers, but when a substantial part of the lamb supply of an area is sold under contract, filling



Sheep grazing in the mountainous area of Montana. This state is third in the United States in the raising of sheep.

(U.S.I.S. photo.)

much of slaughter demand, the marketing and pricing of the lambs not contracted can become variable and unpredictable.

Moreover, pricing policies for lamb carcass and cuts sometimes are so unresponsive to changing supply as to contribute to price weakness for live lambs. Failure of wholesale or retail prices to decline as supplies increase prevents retail outlets from expanding quickly and forces market supplies of live sheep and lambs to back up and prices become depressed. For example, according to data from New York as reported by the Market News Service, prices of lamb cuts at retail declined little last November and December while live lamb prices were dropping, and therefore the difference between the two widened. Only after the first of the year did retail prices begin to drop appreciably, and live-retail relationships to return closer to those of a year earlier (Table 8). While the data are not an exact measurement, other comparisons, without exception, show similar results.

New Zealand farmers are generally interested in the relative profitability of United States lamb feeding. A conversion to New Zealand currency has been made (£(NZ)1 = $2.80). The data

TABLE 8: Comparisons of Composite Prices of Lamb Cuts at Retail, New York, with Prices of Lamb at Chicago, per 100 lb of Live Lambs, 1958 to date (revised).

Period	*Retail price lamb cuts** (£NZ)	*Live lamb price†* (£NZ)	*Difference‡* (£NZ)
1958			
January to March	11.45	8.65	2.79
April to June	11.43	8.35	3.08
July to September	11.88	8.76	3.12
October	11.92	8.48	3.44
November	12.12	8.14	3.98
December	11.85	7.07	4.78
1959			
January	11.16	6.91	4.25
February	10.74	6.95	3.78
March	10.78	7.34	3.44

*47.2 lb †Choice and prime
‡Not a live-to-retail spread, as it is not corrected for value of by-products

in Table 9 are calculations for a standard lamb-feeding programme in the Corn Belt. Costs include only those for feed and feeder (store) lambs. For 1958, there would have been a loss except for the incentive wool payment.

While space does not permit a discussion of live cattle imports into the United States, these totalled approximately one million head in 1958 and came largely from Canada and Mexico. Only a relatively small percentage of these cattle were for immediate slaughter. They consist largely of store cattle and dairy females.

Prices and Consumption

Figures that have appeared in the New Zealand press stories about the retail price of American meat have been noted with interest. While high relative to New Zealand prices, they do, however, fall considerably below those frequently quoted. It will be noted from Table 10 that prices have largely reflected the supply situation. This can be noted particularly for beef in 1952.

TABLE 9: Average Price and Values of Important Items Affecting Returns from Lamb Feeding 1953-58, Under U.S. Corn Belt Conditions.

	1953	1954	1955	1956	1957	1958
Prices:			(*all £NZ*)			
Slaughter lambs per 100 lb liveweight	7.89	7.72	7.00	7.59	8.45*	7.07*
Feeder lambs per 100 lb liveweight	6.08	6.31	6.30	6.57	7.61	7.98
Maize per bushel	0.48	0.48	0.40	0.42	0.33	0.34
Lucerne hay per ton (2,000 lb)	8.15	7.65	6.99	7.25	5.79	5.91
Receipts, per head:						
Sales, 85 lb livewt.	6.70	6.56	5.95	6.45	7.18	6.01
Wool payments (incentive)	—	—	0.23	0.21	0.10	0.30†
Total	6.70	6.56	6.18	6.66	7.28	6.31
Cost, per head:						
Feeder lamb, 60 lb	3.65	3.78	3.77	3.94	4.56	4.78
Maize, 2½ bushels	1.21	1.21	1.02	1.05	0.83	0.86
Lucerne hay, 150 lb	0.61	0.57	0.52	0.54	0.43	0.44
Total for items shown†	5.48	5.57	5.32	5.54	5.83	6.09
Margin, value over costs shown‡	1.22	0.99	0.86	1.12	1.44	0.21

*Choice lambs beginning January, 1958.
†Estimate based on April, 1958, to January, 1959, grower prices.
‡Does not include purchasing or marketing expenses, labour cost, death losses, and overhead costs.

Although the reduced supply of meat has contributed to higher prices in the last two years, it appears that rising consumer income has also had an appreciable influence on demand.

This subject cannot be left without reference being made to poultry meat, which usually costs less than red meats. The very sharp increase in poultry consumption in recent years is due

TABLE 10: Consumption and Retail Price of Beef and Pork and Consumption of All Meat, January to March Quarter, 1952, to date (revised).

	Beef		*Pork*		
	Consumption per person (lb)	*Retail price (lb) shillings**	*Consumption per person (lb)*	*Retail price (lb) shillings*	*Red meat consumption per person (lb)*
1952	14.4	6s. 4d.	19.3	4s. 0d.	36.3
1953	17.9	5s. 1d.	17.7	4s. 1d.	38.7
1954	20.0	4s. 11d.	15.0	4s. 11d.	38.5
1955	19.5	5s. 0d.	17.2	4s. 0d.	40.1
1956	21.3	4s. 5d.	18.7	3s. 5d.	43.4
1957	21.5	4s. 9d.	15.9	4s. 1d.	40.8
1958	19.5	5s. 8d.	15.1	4s. 6d.	37.4
1959†	19.1	6s. 0d.	16.8	4s. 3d.	38.5

*Choice grade †Preliminary estimate

principally to the year-round availability of high-quality poultry meats at very attractive prices. Production and consumption of poultry relative to red meats is shown in Table 11.

Manufacturing Beef

During the past year, the term "manufacturing beef" has come to be well known in New Zealand. It is an essential component in sausage production and more particularly smoked or cooked sausage, such as frankfurters, weiners, and bologna. These three products in 1958 made up 57 per cent. of the Federally inspected sausage output.

The low level of beef production, particularly cow beef and the lower grades generally used for processing, has probably led to some replacement of beef by pork. Nevertheless, processors do not favour too much substitution, and reduced domestic beef supplies have encouraged larger imports of processing beef. Imports of boneless and prepared or processed beef in 1958 totalled more than 425 million lb. product weight, four times as large as similar imports in 1957. Fresh and cured beef and veal inspected by the

TABLE 11: Production and Consumption Per Person of Red Meat and Poultry, United States, 1956 to 1958, and Forecast for 1959.

	Red meat						
	Beef	*Veal*	*Lamb and mutton*	*Pork*	*Total*	*Poultry meat*	*Red and poultry meat*
				Production			
	(*mil. lb*)	(*mil. lb*)	(*mil. lb*)	(*mil. lb*)	(*mil. lb*)	(*mil. lb*)	(*mil. lb*)
1956	14,462	1,632	741	11,218	28,053	5,197	33,250
1957	14,211	1,528	707	10,478	26,924	5,440	32,364
1958	13,342	1,189	688	10,528	25,747	6,049	31,796
1959	13,600	1,150	750	11,700	27,200	6,475	33,675
				Consumption per person			
	(*lb*)	(*lb*)	(*lb*)	(*lb*)	(*lb*)	(*lb*)	(*lb*)
1956	85.4	9.5	4.4	67.4	166.7	29.8	196.5
1957	84.6	8.8	4.2	61.5	159.1	31.4	190.5
1958	80.5	6.7	4.1	60.7	152.0	34.1	186.1
1959	80	6.4	4.4	66.5	157.5	36.2	194

United States Department of Agriculture Meat Inspection Division, when offered for importation, totalled 132 million lb during January to March, 1959, nearly double that of the same months last year but a little below the highest quarterly rate for 1958.

Cattle slaughter this year has lagged about 7 per cent. below a year ago and beef production has been down slightly. Fed cattle slaughter has been above last year, and cow slaughter, chief source of manufacturing beef, has continued to decrease.

This shortage will continue until the relatively short supply of cow or other grass beef slaughter expands appreciably. Some seasonal gain will occur next September to November, when cow

slaughter may climb back to the level of last fall or exceed it slightly. Nevertheless, barring liquidation of herds owing to dry weather, slaughter of grass cattle will likely remain relatively small this year.

Production Capacity of the United States

While costs in the United States seem high, yet on a productivity basis American beef producers appear to be doing quite well. During the past thirty years cattle numbers have increased 43 per cent. and output per head 44 per cent. Space does not permit a discussion of the improved techniques being used, but their effects can be appreciated when it is realized that, while Argentina and Brazil combined have considerably more cattle than the United States, their production is only half as great.

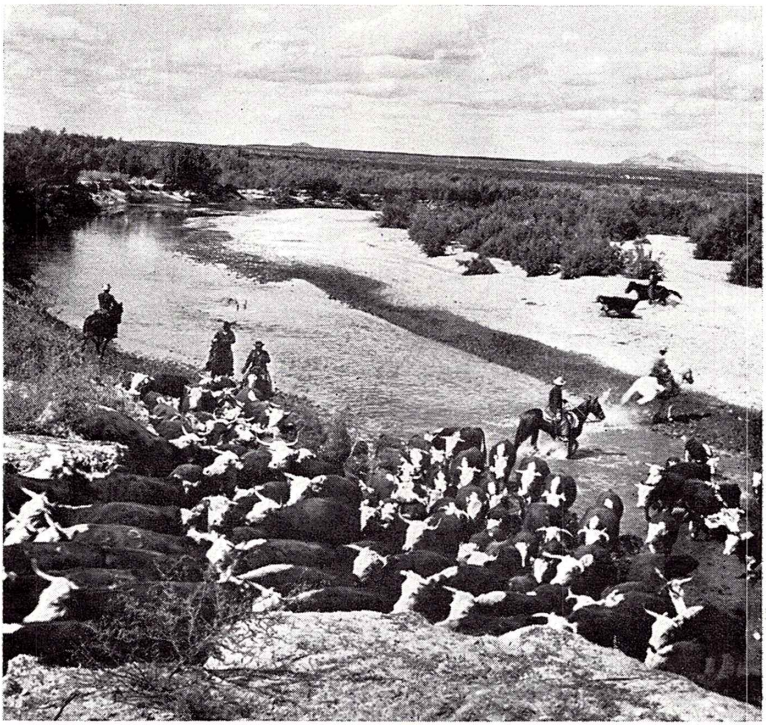
Any discussion of increasing productivity rather quickly brings one face to face with certain adjustment problems. These problems vary considerably, both as to their nature and likely solution. It is quite clear that, both in New Zealand and the United States, record levels of production result as a response to both increasing demand as well as adoption of improved technologies and management practices. It is of interest to note what has been happening in the United States.

With emphasis in America on arable agriculture, it may be somewhat surprising that, in response to demand generated during the post-war period, livestock production has increased more than 20 per cent. compared with only 5 to 6 per cent. for grain through 1957.

American farmers have been substituting non-farm inputs for land and labour. The farm worker today is supporting himself and 23 other persons, nearly twice as many as 12 years ago.

During this period of time, however, the farm worker's real income has decreased, while that of the industrial worker has increased. To offset this, he has tended to raise his production if the return warranted the expense—the result, greater crop yield per acre and more livestock per unit.

The question has frequently been raised as to the ability of the United States to produce to meet future needs. With an estimated population of 230 million and with a 40 per cent. increase in real consumer incomes, together with a moderate increase in consumption, projections on increased demand have been made for 1975 relative to 1956, and are shown in Table 12.



Hereford cattle being shifted on a range in Montana's central region. (U.S.I.S. photo.)

TABLE 12: Projected Increase in Demand for Livestock and Livestock Products.

	Per cent
All livestock	40
Meat animals	47
Poultry	56
Eggs	36

What can be seen in the way of gains in output per animal for the same period?

Production (per animal unit)	
Beef per cow	7
Pork per litter	27
Milk per cow	27
Eggs per layer	12

Increased livestock efficiency in the conversion of feed will be assisted greatly by the use of additives. (These include hormones, anti-hormones, antibiotics, tranquilizers, and other new materials.)

American agriculture is changing from a business of arts and crafts to one of science and technology. It is quite apparent that a great many American farms are too small to be managed efficiently. To exploit capable management, requirements for both the land and equipment are large. Changes will not, however, come easily. Through their social and political systems, Americans have been wedded to the family farm. The small-size family farm has, however, frequently been associated with high cost operations and inadequate farm income.

From the foregoing, it is quite clear that much can be done to increase efficiency of production. There is also little question that it is the consumer who generally benefits most from the products of agricultural research and improved technology. It is appreciated today, more than ever before, that Americans will need to use their newer knowledge in order to compete both in the home and in the overseas markets. No longer can either American production or markets be considered detached from the rest of the world. In this context, however, what is needed is not just a world free from hunger but one where improved nutrition and health standards will result in a more stable world society.

Market Development

This leads to the final and closing point—namely, that of market development. This is in itself a subject of considerable complexity and apparently, at times, of even greater misunderstanding. It is a matter that involves far more than simply salesmanship. It involves discovering that which the consumer needs, translating these needs into expressed desires, and then providing a product together with services in such a manner as to assure consumer satisfaction. Personal preconceived ideas on consumer preferences are often a severe limitation, since they preclude the objective approach.

In considering expenditures for meat and other products, recognition must be given to the increasing tendency of Americans to dine out, as well as their greater use of convenience foods. Today, institutional outlets strive for greater control over costs,

quality, and size of portion. Convenience foods offer these same advantages to the home-maker. They make preparation of meals simpler and more convenient. They add another helping hand or, in short, provide a "built-in maid service". Just as science and technology have been used to produce more efficiently, the use of newer and more scientific methodology in market development is essential if costly mistakes are not to be made.

DISCUSSION

Q:: *Has the increased production in the United States come about by increased efficiency or by an increase in the area being farmed?*

A:: The increased production acreage-wise has largely resulted from increases in efficiency. The actual acreage farmed today is practically unchanged from that of forty years ago.

Q:: *Does that answer refer also to beef production?*

A:: During the past thirty years cattle numbers have increased 43 per cent. and output per head 44 per cent. Thus, both greater efficiency and greater numbers have contributed to increased beef production.

Q:: *Would the speaker care to discuss the shipment of live lambs from Australia to the United States? What is the general practicability of this practice?*

A:: I am sorry that I am not qualified to discuss the shipment. I have, however, followed the Press reports with interest.

Q:: *Could the speaker indicate why the lamb imports from Australia in 1958 were approximately double those from New Zealand?*

A:: It is my understanding that Australia generally sells its lambs on a consignment basis while New Zealand does not. This apparently favours Australian sales.

Q:: *How long can the American Government continue subsidizing farmers to produce surpluses?*

A:: Less than one-quarter of agricultural production is subsidized. A great deal of the United States production which is in excess of domestic use is in no way related to Government loans or payments. We recognize that one alternative to Government subsidies lies in larger farm incomes resulting from greater efficiency in production and marketing.

Q:: *Why, if only 12 per cent. of farmers contribute most to production, do they have so much power?*

A:: The question here is obscure. What seems to be inferred is that larger commercial farmers have an unusual amount of political influence. I do not believe such an assumption is valid.

Q:: *To what extent does fat on our lambs militate against them on the American market? Does less fat on the Australian lamb make it more favoured?*

A:: I am sorry but I do not have any first-hand information on this point. It is true, however, that excessive fat is undesirable regardless of country of origin. It appears that Australia does enjoy some advantage in this respect.

Q:: *We produce a dual-purpose sheep. There is a 23 cent tax on wool imported into the United States. Would you tax New Zealand meat or lower the tax on New Zealand wool?*

A:: Out of some 44.5 million lb clean content of wool imported from New Zealand for consumption in the calendar year 1958 there was slightly over 32 million lb entered duty free for use as floor coverings. Only 12½ million lb of wool were dutiable in that year. Duties on New Zealand wools range from 13 cents to 25½ cents per lb, clean content, depending on the quality count. Duties on meat are quite nominal, approximating 3 cents per lb. I know of no proposed changes in duties.

Q:: *Why are Americans so fond of New Zealand bull beef?*

A:: Sausages generally, and smoked sausages particularly, such as frankfurters, weiners, and bologna, are especially popular in the United States. Because of the excellent binding qualities of bull beef it is especially sought after as a principal component of these sausages.

Q:: *Is automation taking on in the feeding of beef cattle in the United States, and if so, what effect will it have?*

A:: There has been an increase in the use of mechanization in beef cattle feeding in the United States. This makes automation feasible. The use of automation has, as its objectve, reduction in cost, particularly labour. When overall savings result, automation increases. While it is yet early to make an evaluation, the results appear promising.

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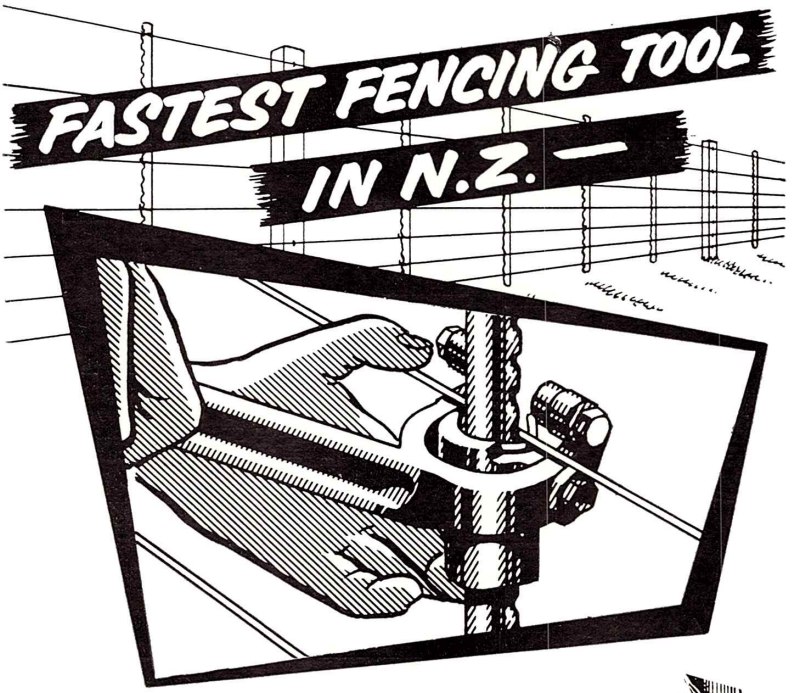

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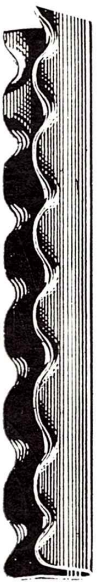

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THE GRADING OF CARCASSES FOR EXPORT

S. H. SMITH-PILLING*

IT IS IMPORTANT THAT PRODUCERS should fully understand how their stock is graded, why certain standards have been adopted, and what measures are taken to ensure that export grading is consistent and fair to all.

Prior to the formation of the Meat Producers' Board in 1922, there was no supervision of export meat grading and therefore meat exporters set their own standards. For many reasons, this was not in the best interests of producers or, for that matter, the industry generally. From the outset of its administration the Board took steps to standardize grading throughout New Zealand and to ensure that all meat sold on overseas markets complied strictly with the grade specified.

Starting with a small team of supervisors, this task proved difficult because, as would be expected, some exporters were reluctant to depart from their own standards; however, by taking a firm stand and with a strengthened grading team standardization was eventually brought about.

Our system of grading control has been the subject of much criticism from within New Zealand but the results achieved, as evidenced by the reliance placed on our grading by overseas buyers, is an effective answer to these criticisms. It is significant that other meat exporting countries having what would appear to be an ideal system of controlling meat grading are envious of the reputation New Zealand grading enjoys overseas and accordingly they have evinced much interest in the system operating here.

When in the United Kingdom in 1957 the writer had the opportunity of meeting many retail butchers, and from discussions with these people gathered that one of the reasons for the immense popularity of New Zealand lamb on the United Kingdom markets is the consistency of its grading.

Possibly one of the most important factors responsible for the success of the New Zealand grading system is that the supervision is carried out by men who have had previous grading experience. Where the supervision is under control of persons lacking a practical knowledge of grading, there is a marked tendency for grading

*N.Z. Meat Producers' Board, 189 Ferguson Street, Palmerston North.

to become relative, *i.e.*, standards are related to the general quality of the carcasses seen. On visits overseas much evidence of this has been seen where standards vary from State to State. In those States where there was a preponderance of good quality stock, grading standards were higher than in States where the bulk of the stock was of poor quality.

Purpose of Grading

The main purpose of grading is to make possible a determination of values. Grading makes it possible to distribute the various types and qualities of meat to suit market preferences which is important if all are to get the best possible financial return for the product. Reliable grading standards encourage the butcher to order his requirements by telephone, thus saving time in visiting the market or depot to select his meat.

What are the Main Essentials of an Export Grading System?

(1) It should have permanence. No system of grading which is influenced by geography, season of the year, pasture conditions, market fluctuations, or the standing of the vendor, can have any real value. Obviously, if the system were subject to such variations, overseas buyers would place no reliance on it.

(2) It should fit the requirements of the trade because no system of grading would have any value if it ran counter to the fundamentals of trade practice.

(3) It should be realistic and workable.

(4) It should be specific. Whenever a carcass or part of a carcass is placed in a given grade it should be placed there for some definite reason which can be explained and demonstrated to the vendor or drafter. Individual fancy or personal prejudice can have no place in a standard grading system.

How Does Export Grading Operate?

First of all it would be as well to point out that export grading is something quite apart from the grading of meat for local consumption (grade striping). Local consumption standards bear little, if any, relation to export standards and, furthermore, local consumption grading comes under the supervision of meat inspectors employed by the Department of Agriculture.

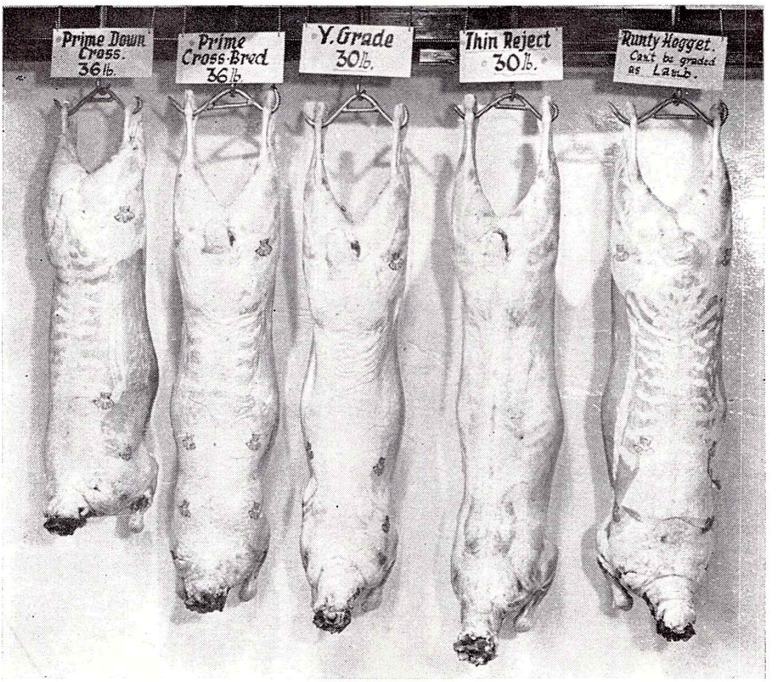

Fig. 1: *The three export lamb carcass grades are shown at the left of the illustration together with a reject lamb carcass. The runty hogget cannot be included in lamb grades. Note dark coloured "bark" (panniculus muscle) of the hogget carcass.*

Export grading is carried out by meat graders employed by the freezing companies. These graders usually commence as ticket boys attaching the appropriate grade tags to the carcasses. In this job, they learn the fundamentals of grading because they work next to experienced graders.

Carcasses are graded at the weighing point where grade and weight are recorded on individual vendor's killing sheets. This grading is checked by the works' head grader with a minimum of delay and any necessary corrections are made. Grading is also checked by the Meat Producers' Board supervisor who pays frequent and, in some instances, twice-daily visits to works in his district. The primary duty of the Board's supervisors is to see that grading standards are maintained at a constant level. High

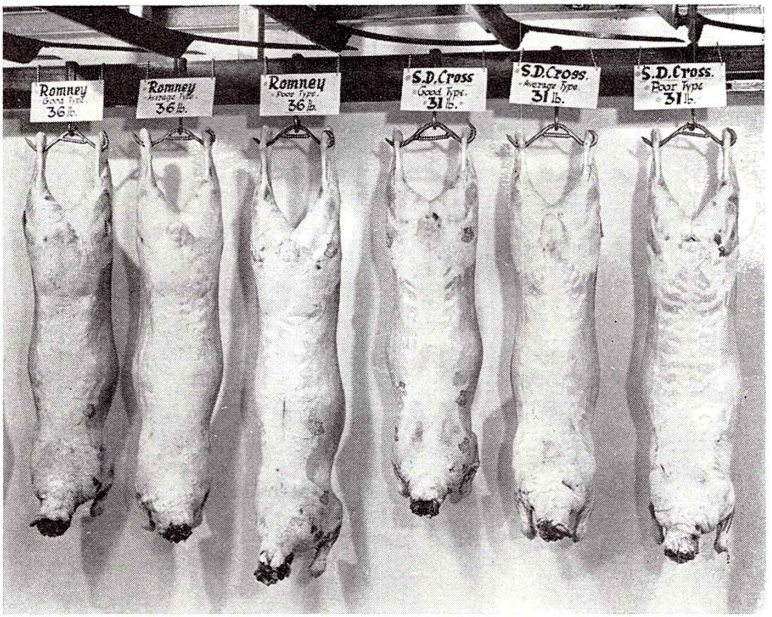

Fig. 2: Note wide variation in conformation within a breed or cross. To make valid comparisons, carcasses within each group were selected on an equal weight basis. Differences in age of the lambs at slaughter were not great.

grading is adjusted just as is low grading, and this point is emphasized. In point of fact, high grading is regarded as more serious than low grading for the reason that when grading is too high not only is the producer penalized unnecessarily but the inclusion of fat carcasses in the lower grades would only bring complaints from overseas markets. The bulk of the lower grade carcasses goes to markets where consumers prefer meat with little fat cover. On these markets, well-finished carcasses are difficult to dispose of and usually have to be sold at a discount.

As a safeguard against the supervisor's standards being influenced by the quality of the stock killed in his particular district there are interchanges of visits between districts from time to time. Further to this, the Board's chief supervisor visits all districts occasionally, it being his duty to co-ordinate the work of the whole team.

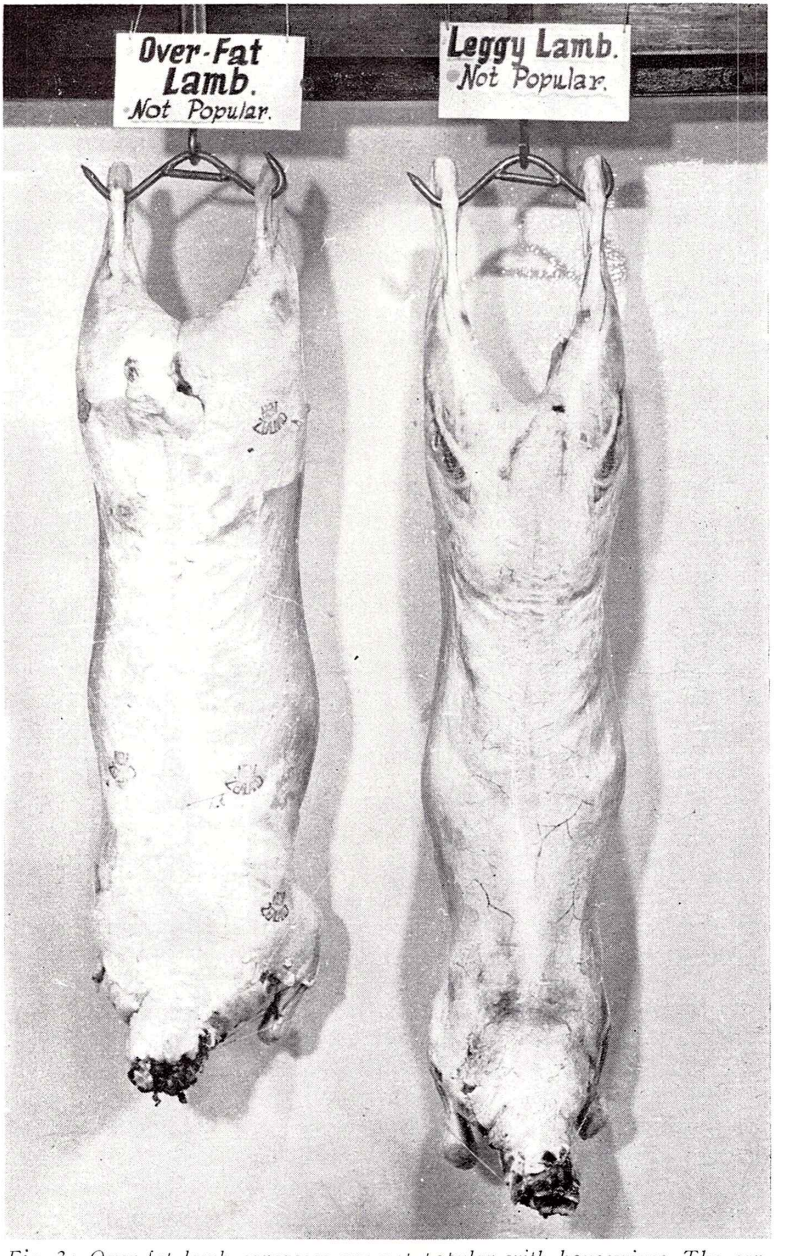

Fig. 3: Over-fat lamb carcasses are not popular with housewives. The carcass showing this fault weighed 44 lb and was a Southdown-Romney cross. Leggy lambs, because depth of flesh is lacking, dry out excessively in cooking and thus lose succulence. Breeders should avoid producing this type.

Lamb Grading

The definition of a lamb for export purposes is: A sheep under 12 months of age; provided that all sheep born during any year shall be hogget as from 30 September in the following year.

The minimum weight for export lambs is 20 lb and the maximum 56 lb. Lamb carcasses 57 lb and over are included in the wether mutton grades. The Prime Down-cross grade put up in the North Island now has a maximum weight limit of 36 lb and those over 36 lb are incorporated in the Prime Crossbred grade as are all weights in the South Island.

The grader's first action when grading lamb carcasses is to grasp the flank of the carcass taking a quick glance at the internal finish and at the same time noting if any sponginess of the flank is apparent. Considerable importance is placed on the feel of the flank for the reason that the condition of this part indicates to the grader whether the carcass is puffed up with air within the tissues thereby giving a false impression of fullness of flesh. The grader then turns the carcass and looks at the fat situation on the back. To make the prime grades there must be a good distribution of fat extending over the carcass from neck to hock but it may be somewhat sparse towards the extremities; it is essential that there be an ample covering of fat to protect the underlying muscles of the valuable leg and loin cuts.

If the fat cover is slightly deficient and the grader is in doubt as to how the carcass will cut he feels the loin. The feel of the loin gives a reliable indication of the meatiness of the carcass since this is the last part of the animal to develop; if the loin is filled out the carcass will cut well and in this case a slight deficiency of fat covering is overlooked.

If the carcass meets the requirements of the prime grades and is within the 20 lb to 36 lb weight range, the grader then assesses its conformation, placing considerable importance on the fleshing of the legs and loin because these are the most valuable parts. He looks for thickness and shortness of leg and for width and flatness of loin. The fore-quarters are of less importance to him except when there is doubt as to which grade to allot the carcass. In such instances the development of the shoulders may be the deciding factor whether the carcass is graded Prime Down-cross or Prime Crossbred.

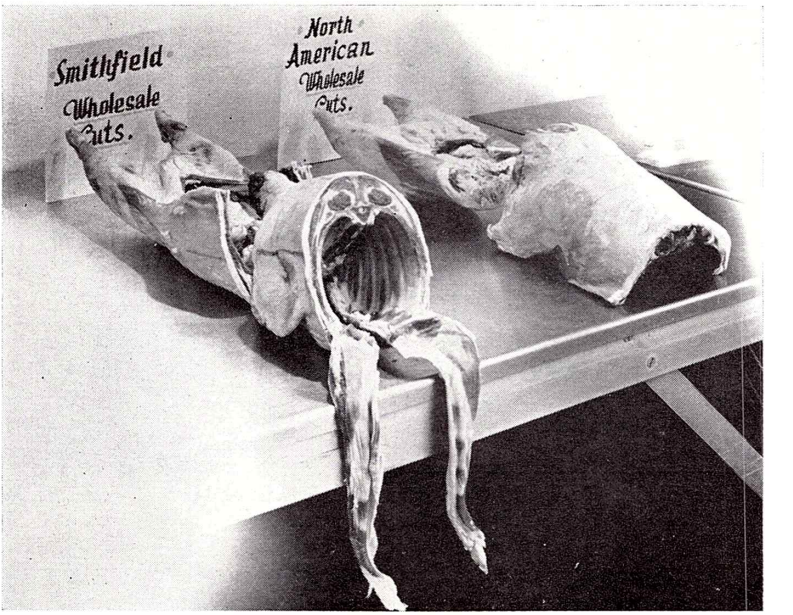

Fig. 4: *Wholesale cuts of lamb of two different markets. The carcass for the North American market has had the shanks, flanks, and scrag (neck) removed before packaging for export. At Smithfield some types of carcasses sell more freely if cut in the manner illustrated. This cutting is done on the market.*

Other factors influencing the grading of lambs are:

(1) *Fat colour*: For the prime grades fat colour must be within the range of white to light yellow. If the fat is a deep yellow the carcass will go into the Y grades and if greenish-yellow it will be rejected.

(2) *Bruising, wool-pull, and dog-bite*: Of the three types of bruising damage, wool-pull is the most common—all too common. Fortunately wool-pull damage is not usually deep-seated and dropping the carcass into the Y grade meets the case. Only a small percentage of carcasses are rejected for wool-pull damage. Ordinary bruising may vary considerably in severity. It may result in the carcass being dropped a grade, rejected, or condemned depending on the part affected and the extent of the damage. Dog-bite, the most serious of the three types, fortunately, is relatively rare. As dog-bite almost invariably causes bleeding in the seams of the meat this type of bruising usually results in the carcass being rejected or condemned wholly or in part.

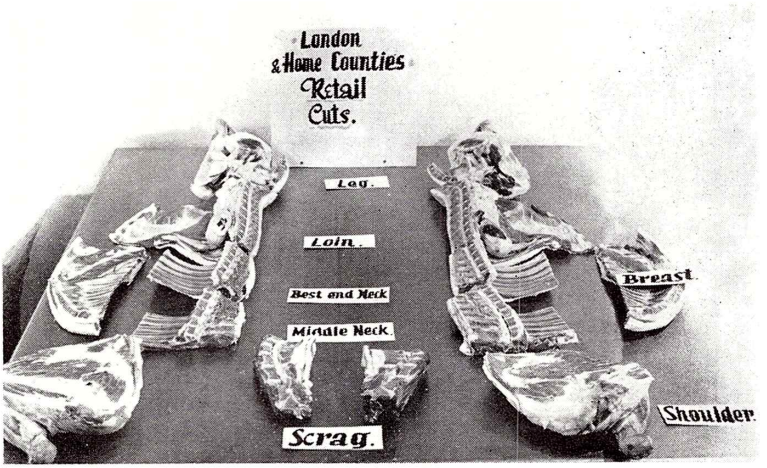

Fig. 5: *The London and Home Counties butchers cut lamb carcasses in the manner illustrated.*

(3) *Slaughtering faults*: Carcasses badly mutilated or heavily soiled are rejected. In these instances the vendor is paid the full price according to quality and the loss is borne by the freezing company.

The grader is always watchful to see that runty hoggets do not get through as lambs. Quite often these come in with lambs but whether by accident or design it is difficult to say. Runty hoggets are distinguished from lambs by the following features:

(1) Size of shank bones (tibia and radius). The shank bones of runty hoggets are usually smaller than those of lambs of comparable size.
(2) Colour of "bark" (panniculus muscle). The bark on hoggets is darker than that on lambs.
(3) Colour of ends of shank bones. Bone colour at these points is greyish-white in hoggets and purplish in lambs.
(4) The flexibility of the brisket bone (sternum) when bent outwards. There is markedly less flexibility with hoggets. Naturally this test has to be carried out before the onset of rigor mortis, *i.e.*, before the carcass sets.

There are other features too numerous to mention and some difficult to define which indicate quality to the experienced grader and which have an influence on the grading of lambs.

There are five standardized weight ranges for Prime Cross-bred and two for Prime Down-cross. It is not mandatory to

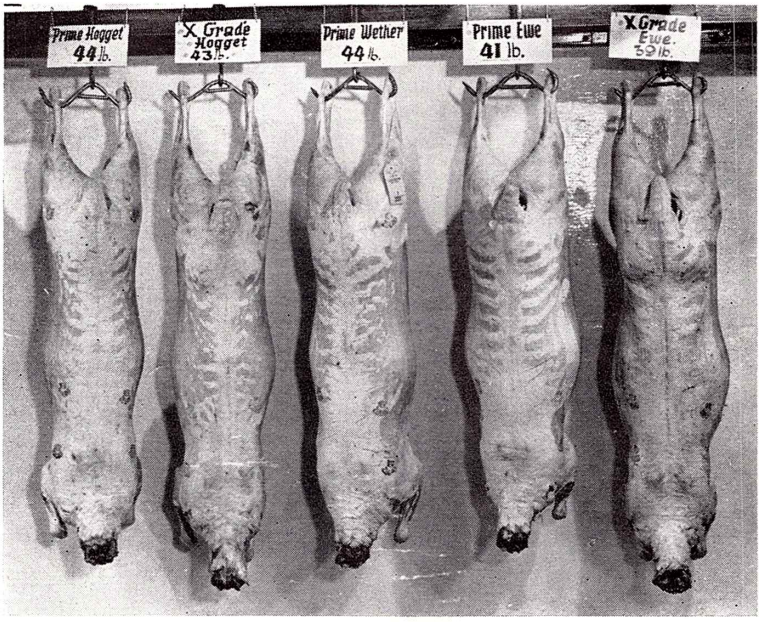

Fig. 6: Export grades of mutton and hogget.

divide Y grade lamb carcasses into weight ranges but the majority of meat exporters parcel three weight ranges.

Hogget Grading

The requirements for the hogget grades are: Carcasses must be from either wethers or maiden ewes not showing more than two permanent incisor teeth. In addition the dressed freezing weight is not to exceed 56 lb and the carcass must have the characteristics of a young animal. (Note: The meat trade hogget is really a two-tooth sheep and not a sheep in its first winter.)

Late in the killing season due allowance is made for the early eruption of the second pair of permanent incisors. It is known that some hoggets, particularly those which have been on crops, sometimes erupt their medial incisors as early as 19 months. However, most hoggets with early erupted medial incisors weigh out at over 56 lb and so are automatically graded as wethers.

To the experienced eye the characteristics of a young sheep are:

(1) Paleness of "bark" (panniculus muscle).
(2) Absence of rinyness of "bark".

(3) Paleness of flesh between the ribs (intercostal muscles).
(4) Pinkness of rib bones.
(5) Flexibility of brisket bones (sternum bones) when bent outwards. This test has to be made before the onset of rigor mortis.

Both 1st and X grade hoggets may be exported.

The grader's procedure in grading hoggets is much the same as in grading lambs except, of course, there is no Prime Downcross grade. The flank of a hogget carcass has a harsher feel than that of a lamb and there is seldom any sponginess which is so often noticeable in lambs. Fat cover requirements are much the same as for lambs. Very coarse carcasses are dropped into the wether mutton grades but the percentage of young animals down-graded for this reason would be very small. Where there is a slight deficiency of fat cover the grader is influenced by the conformation of the carcass when coming to a decision as to which grade to allot it.

With hogget grading stagginess is responsible for a fair percentage of carcasses being dropped into the X grades.

Early in the season a number of hoggets are found which have not erupted their first permanent incisor teeth. This condition has sometimes been noticed as late in the season as January. Because of this, and, as there is a marked similarity between temporary incisor teeth and the well-worn permanent incisor teeth of a full-mouthed sheep, graders are taught to readily distinguish between the two.

Hoggets are usually divided into two weight ranges, 48 lb and under, and 49 to 56 lb.

Wether Mutton Grading

There is no maximum or minimum weight for the wether mutton grades. Carcasses from maiden ewes are included in the wether grades provided the udders are clean and immature, and which, when incised, have the appearance of pure fat.

Maiden ewes which have been grazing on pastures with certain types of clover predominating have been found to have milky udders closely resembling the suckled udder of a ewe which has lambed. In cases where farmers are not aware of the influence these types of clovers have on the udders and reproductive organs of ewes, some misunderstanding results.

The fat cover requirements for wethers are slightly less exacting than for lambs or hoggets. As is the case with hoggets,

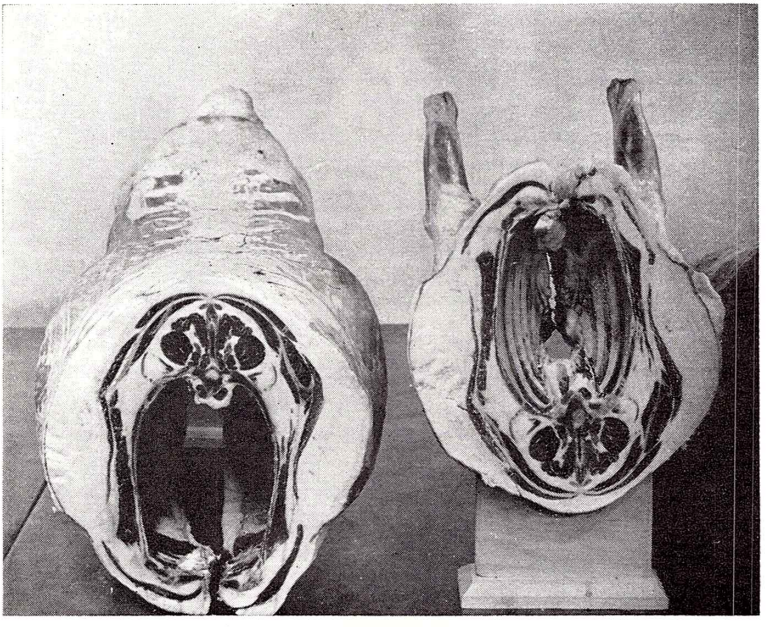

Fig. 7: An over-fat ewe mutton carcass.

stagginess is responsible for the down-grading of a fair percentage of wethers.

Ewe Mutton Grading

As is the case with wether mutton, no weight restriction applies in respect to ewe mutton. The heavier carcasses, however, are more often than not boned-out since it is uneconomic to export these in carcass form through ordinary marketing channels.

Dividing ewe mutton into two quality grades is optional but most meat exporters make two grades. There is a minimum quality requirement for the E grades; where two grades are put up carcasses must not be below the minimum requirement.

Grossly wasteful carcasses are not permitted in the ordinary E grades but may be exported in carcass form carrying the appropriate description on tags and wraps.

Beef Grading

Before discussing the various grades of beef it would be as well to clear up some misunderstanding that exists in respect to the grading of heifers.

The United Kingdom meat trade will not accept beef as heifer unless the udder is left intact. Furthermore, the udder must be firm and immature and when cut must have the appearance of pure fat. In recent years there has been a marked resistance to heifer beef in the United Kingdom. The new generation of meat tradesmen there are well informed on the economics of the trade. They know that heifer beef is wasteful cutting except at very light weights. To them all heifer beef is suspect, particularly that from heavier, older animals. Where the udder is not absolutely clean, the beef is immediately classed as cow beef. The cause of a change in udder condition is of no particular interest to the United Kingdom butcher, since, at this stage, he is unable to determine, with any degree of accuracy, the reason for such a change.

It is because of the most exacting requirements of the United Kingdom meat trade in respect to heifer beef that graders are required to examine udders closely. As a consequence, on occasions, what appears to be a heifer to the farmer is graded as a cow at the freezing works.

There are a number of factors which can bring about a change in udder condition. The main reason, of course, is pregnancy. Other causes are an early abortion, flushing when on heat, and the sucking of the teats by stray calves. On occasions speyed heifers have to be graded as cows because of change in udder condition brought about by the teats being sucked.

Ox and Heifer Beef Grading

Prime ox and heifer beef may be divided into three quality grades, namely, Baby Beef, Selected Chiller Quality, and ordinary G.A.Q. (good average quality).

Baby Beef, which is the top grade, is not put up by some exporters and others may do so only to cater for certain markets or for chilled beef shipments.

To qualify for the Baby Beef grade, carcasses must be from young steers or heifers within the weight range 400 to 720 lb. Carcasses must be of good conformation and carry a smooth, even fat finish. There must be an abundance of cartilage showing on the brisket bones, pelvic bones, and vertebral spines. Fat colour must not be deeper than creamy-white. There must be no evidence of stagginess.

The Selected Chiller Quality grade is used for beef shipped in the chilled state. On occasions, when there is a poor demand for

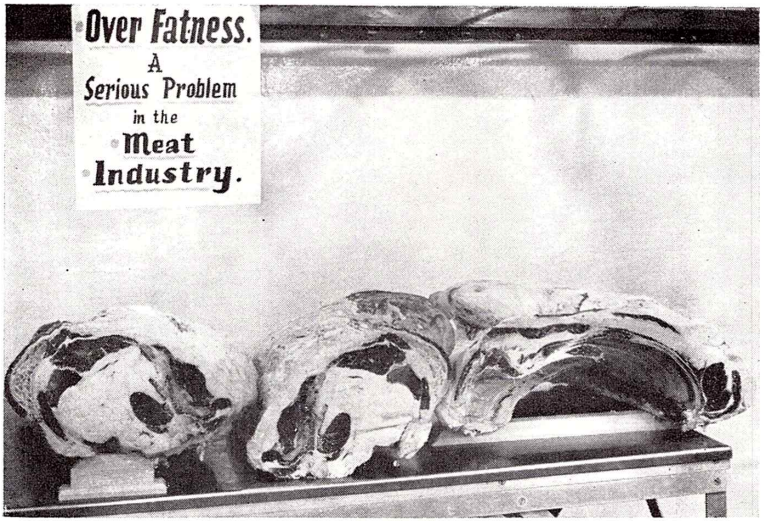

Fig. 8: Over-fat cuts of cow beef. Such meat is usually boned-out and defatted. A similar carcass yielded 130 lb of wasteful external fat when trimmed for the retail trade.

chilled forequarters, these may be sent in the frozen state carrying the tag "Frozen Chiller Quality".

The requirements for the Selected Chiller Quality grade are similar to those for the Baby Beef grade. The main difference is that carcasses from slightly older animals can be included, consequently the requirements in respect to fat spread are not so exacting. Excessively fat carcasses are excluded, as are staggy carcasses.

The G.A.Q. grade, broadly speaking, takes in all carcasses from beef-type cattle which have a reasonably good fat finish. Fat cover may be somewhat lumpy and unevenly spread but there must be a sufficiency of it over the roasting cuts and buttocks; it may, however, be sparse on parts of the brisket and the extremities. Fat colour may range from white to deep cream. Grossly wasteful carcasses and those showing staggy characteristics are not included in this grade.

When beef is being parcelled for export to markets where there is no price premium for Baby Beef or Chiller Quality beef these qualities are incorporated in the G.A.Q. grade.

Ox and heifer beef not qualifying for the previously mentioned top grades may be graded F.A.Q. (fair average quality) or graded boner quality.

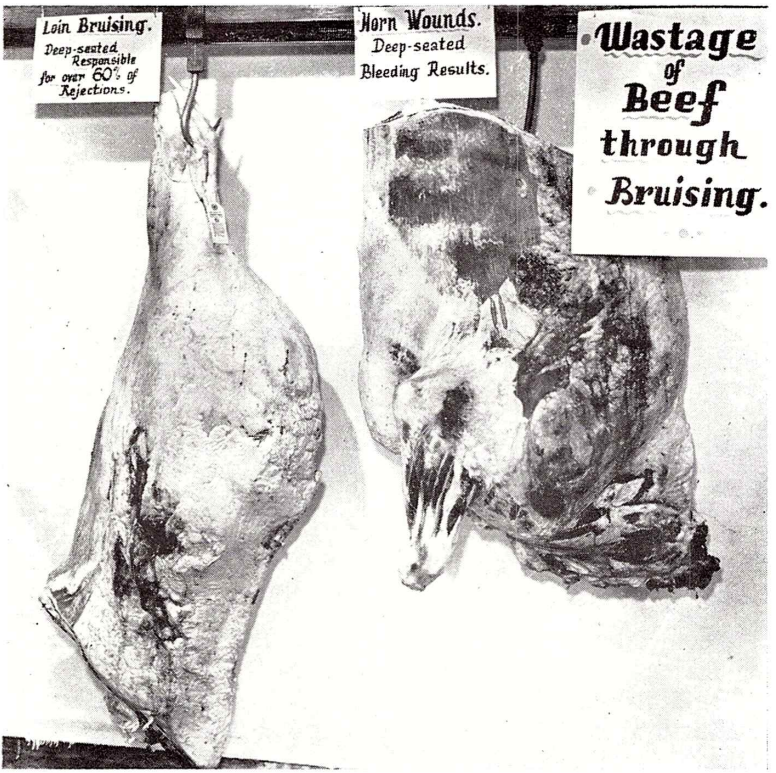

Fig. 9: Types of bruising met with in beef carcasses. Loin bruising is a very common cause of rejection. Horn bruising fortunately is now relatively rare.

For the F.A.Q. grade, carcasses may be relatively long in proportion to width and inclined to be angular; buttocks, loins, ribs, and chucks may be only moderately finished; shoulder joints may be noticeable but not prominent. Fat covering may be somewhat deficient over the roasting cuts, and buttocks; the extremities, brisket, and chuck may have very sparse fat covering. Fat must be reasonably firm and may range in colour from white to light yellow. Slightly staggy carcasses are included in this grade, but not grossly wasteful carcasses.

This grade includes unfinished carcasses from beef breeds and the best of the dairy breeds and crosses.

All carcasses not meeting the requirements of the F.A.Q. grade are graded boner quality. Boner grade beef is usually boned,

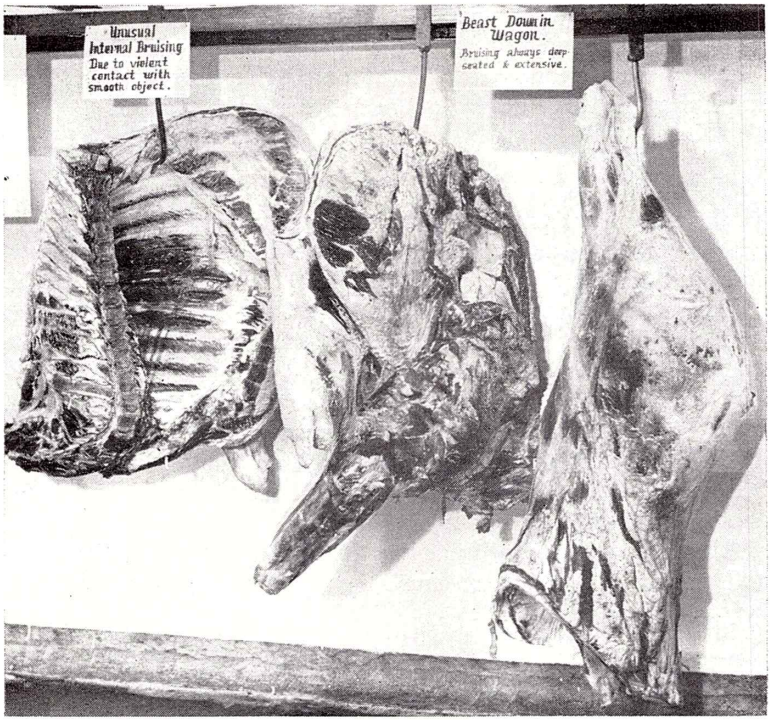

Fig. 10: *The fore- and hind-quarters on the right became extensively bruised because the beast got down in a railway wagon. The main cause of this type of damage is from trucking cattle immediately after long droving. Other causes would be due to putting too many or too few beasts in a wagon and to careless shunting. The fore-quarter on the left showed no sign of bruising externally. Localized bleeding of the damaged muscles between and over the ribs results from this type of injury.*

de-fatted, and cartoned for export. However, should there be a market for this class of beef in the bone-in form, exporters are permitted to cater for this demand. In this event certain requirements in respect to labelling, etc., have to be observed. The Meat Board, while giving meat exporters every assistance to dispose of the produce to the best advantage, take precautions to ensure that the good name New Zealand enjoys on overseas markets is in no way damaged.

Cow Beef

There are three grades of cow beef, namely, G.A.Q., F.A.Q., and boner grade. Some exporters subdivide the boner grade

making the very low quality carcasses canner quality. There is usually a reduction in the schedule price for the canner grade.

The general requirements in respect to conformation and fat finish for the same grades of ox and heifer beef apply.

Veal

The three grades of veal include carcasses from veal calves with a dressed weight within the range 60 to 360 lb. However, it is very seldom that carcasses under 80 lb are exported bone-in.

Requirements for the V grade (first quality) are: Carcasses must be compact, plump, and have a firm flank of reasonable thickness. Rumps, loins, and ribs must have at least a thin covering of fat; kidneys must be well covered; fat must be white. No bull characteristics are to be showing.

Carcasses not conforming to the requirements of the V grade but which have reasonably good conformation and some fat finish, particularly internally, are graded VX (second quality).

All carcasses not qualifying for the V or VX grades are classed as boner and are treated in much the same way as ordinary boner beef.

How Beef Grading is Carried Out

Most freezing companies have now adopted the practice of grading beef in sides shortly after the dressing processes are completed. This grading cannot be regarded as final for the assessment of the value of a carcass. Without examining the eye-of-meat when the side is quartered the preliminary grading can be nothing more than an educated guess. Therefore when beef is graded in sides quite often adjustments have to be made to the grading after these are quartered.

When grading beef in sides, the grader first takes a look at the overall fat situation. If the top grades, Baby Beef and/or Selected Chiller Quality, are being put up, thickness and spread of fat and fat-colour have a profound influence on the grading. The size of the cods or udders, thickness of flank and the internal finish give some indication to the grader of the ratio of fat to lean in the eye-of-meat. Cod-size cannot be taken as a reliable guide to the amount of fat within the flesh. With the introduction of the rubber ring method of castration, which leaves a small, flat cod, and the number of beef-dairy crosses coming forward, very little importance can be placed on the size of cods. (Steers

from dairy breeds have abnormally heavy cods.) Internal finish, also, does not give a true picture of the intermuscular finish, particularly with beef-dairy crosses. Most dairy breeds tend to have heavy accumulations of internal fat even when fat is sparse in other parts.

The grader rightly places much importance on the conformation of the carcass. He looks for fullness of buttocks and loins; excessive heaviness of brisket or cod is undesirable, but the chuck and ribs should be well-fleshed. These are not fancy points but are truly based on the economic usefulness of the carcass. If the conformation is good, other minor faults are overlooked. When in doubt as to how the carcass will cut, the grader grasps the last rib of the side, and the thickness at this point indicates to him whether the carcass is shelly or not.

When putting up the Baby Beef or the Selected Chiller Quality grade, age of the animal is a factor influencing the grading. To determine the age of the animal, the grader examines the cartilage tips of the dorsal vertebrae and notes the amount of cartilage showing on various bones, especially the brisket and pelvic bones. Bone-colour, fat-colour, and flesh-colour are also used advantageously in determining age.

The grader keeps a watchful eye for evidence of staginess. Staginess is manifested by heaviness of cod and neck, development of retractor muscle, colour of flesh, and other features difficult to define.

Acknowledgements

The outstanding help of the management and staff of the Co-operative Wholesale Society Ltd., Longburn Freezing Works, is gratefully acknowledged. The Wairarapa district manager, Thos. Borthwick & Sons (A'sia) Ltd., kindly provided the gate hinges exhibited at the demonstration. L. J. Wingrove, Supervising Meat Grader, New Zealand Meat Producers' Board, gave valuable help at the demonstration.

DISCUSSION

Q:: *What is the reason for the very high percentage of second quality lambs this season? Has the grading been tightened?*

A:: It is true the percentage of second quality lambs in the North Island has been very high this season—the highest on record. However, the average carcass weight of lambs in the North Island this season to 31 May was down to 30.8 lb—an all-time low. Lambs received a set-back in the

early spring owing to abnormally dry weather. Lambs must get away to a good start if they are to do well and that is the main reason for the very high percentage of seconds this season. Another reason is that there has been a swing away from the improved meat breeds which tend to fatten even under adverse pasture conditions. Some of the "off" breeds, which may be profitable to run under favourable conditions, prove difficult to fatten in bad years.

With regard to grading being tightened. Most definitely there has been no tightening of lamb grading.

Q:: *If the term "second grade" is not used on the United Kingdom markets when referring to lightly finished lambs, why is it used in New Zealand?*

A:: It is most unfortunate that we have acquired the habit of using the term "second grade". Undoubtedly there is a sales resistance to the term. Many consumers prefer meat with light fat-cover but they do not like to be reminded that they are eating second grade meat. I am afraid it is going to be difficult to wean ourselves away from the use of this unfortunate term.

Q:: *What, in your opinion, is the best method of castration from the point of view of carcass quality?*

A:: Without doubt the knife gives the cleanest castration. Bloodless emasculators, if in good order and used correctly, are quite effective. However, too often these instruments are used when not in good working order. It is too much to expect these instruments to stand use for years without some attention. It has been noticed that some lambs castrated by this method have one cord incompletely crushed allowing slight development of the testicle.

The rubber ring, if properly applied, gives complete castration. When using this method it is essential that the testicles be gathered into the ring but it does appear that some operators tend to place the ring too high.

Q:: *Is the wide variation in conformation in the three Romney carcasses due to age differences?*

A:: No. These carcasses were selected during the month of June. I would say there is very little age difference. It is remarkable what can be achieved by selective breeding. In the Hawke's Bay district I have seen lines of Romneys which closely resemble Down-cross lambs for carcass conformation.

Q:: *Do you think there should be a grade for over-fat lambs?*

A:: I would not like to comment on that as it is a matter for the Board to decide. You may rest assured that the Board are keeping matters of this nature under consideration. The introduction of more grades adds to transportation and sorting problems.

Q:: *Does the change in udder condition in heifers have any effect on the eating qualities of the meat?*

A:: Frankly, I think it would have little if any effect on the meat. I fully appreciate that the grading of heifers for export must cause farmers considerable concern. However, if the udder is not clean it is not accepted

as heifer beef in the United Kingdom. I am aware that numbers of virgin heifers are graded as cows for export. There is nothing we can do about it, the grading has to be done entirely on udder condition. Butchers do not like heifer beef because it is usually very wasteful. A number of complaints have come from the United Kingdom markets in recent years over our heifer grading.

Q:: *What causes loin bruising in cattle?*

A:: I am pleased that question was asked as I omitted to explain the causes of this damage. There are several factors responsible for loin bruising.

(1) Projections at gateways. Gate hinges with pointed bolt-ends would cause serious bruising if cattle came in contact with those vicious points.

(2) Single-door railway wagons. It has been established that cattle off-loaded from this type of wagon have a higher incidence of loin bruising than those from wagons with double doors.

(3) Narrow doors on the crates used on lorries for the transportation of cattle. There is an urgent need for more attention to be paid to the bruising potential of these cattle crates.

(4) The indiscriminate use of dogs—many not well trained—causing crowding in gateways and through races.

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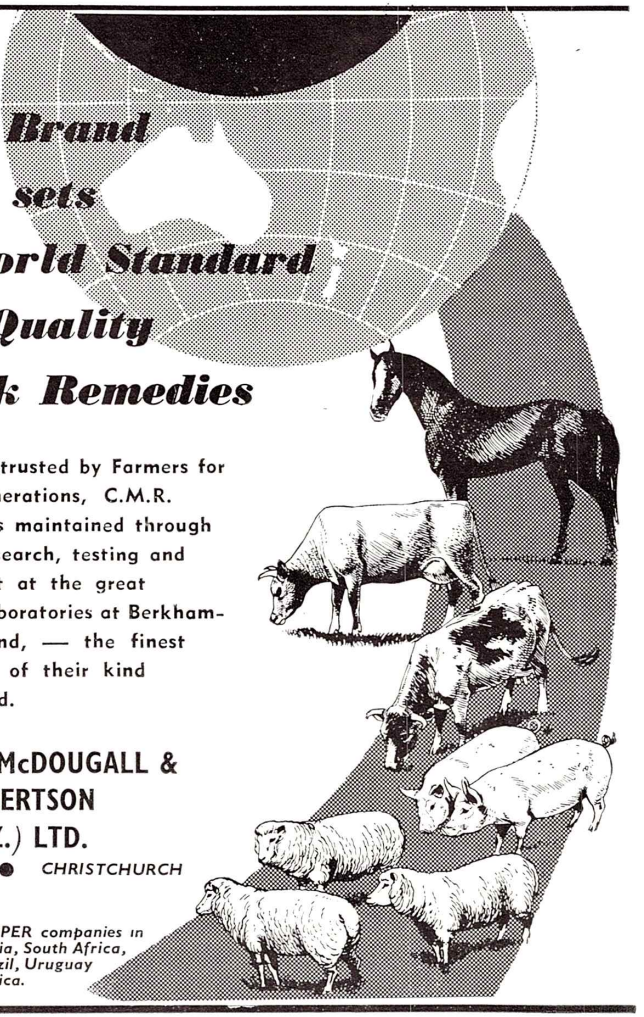

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PROBLEMS IN ATTAINING HIGHER PRODUCTION ON A MANAWATU FAT LAMB FARM

J. M. HARE*

THE FARM DISCUSSED HERE consists of 850 flat acres in the northern Manawatu. It was originally covered in heavy bush, certain areas comprising totara/matai and other areas rata/rimu bush, most of which was felled in the early 1890's. It was purchased by the present owners in 1908. Progress was slow because of lack of capital and the nature of the heavy stumps and logs. However, considerable progress was made before the early 1930's, and by milking cows by hand and cutting expenses to the limit the slump was weathered. Unfortunately, lack of capital was still a handicap.

World War II did not ease the problem of undertaking improvements, and it was not until 1945 that any major improvement programme could be undertaken.

Reasons for Production Increase

It was always felt, probably quite wrongly, that the local community were very critical of the backward nature of our farming. To the writer, this was the greatest spur, and in time became habitual; if there were such things as agricultural psychologists, they would probably describe this attitude as "development fixation" or the urge to develop just for the sheer hell of it.

Added to that was the realization, gained through overseas experience, of the vulnerability of a relatively large block of country to State acquisition. In fact, the first negotiations to take 550 acres from the 800-odd acres had already been made.

While the farm had then only one legal owner, it represented—like most farms—the lifetime efforts of a whole family—man, woman, and children. The retention of the farm by the family was ensured by legalizing joint ownership. Justification for this step, by the determination to better any production which might have been attained by closer single-unit subdivisions, gave an added jab to the spur.

To all this must be added the acute awareness of how much all farmers have to learn about land, grass, and stock.

**Cheltenham, R.D. 4, Feilding.*

Production Stage 1

The farm can be considered typical of only part of the Manawatu. The annual rainfall is approximately 38 in. and the district is rather subject to dry summers.

The farm comprises three main soil types. About two-fifths consists of rather thin silty topsoil over soft, silty clay. Another two-fifths is brown shingle with only an inch or two of topsoil which dries out very badly in dry summers. The other one-fifth, or a bit less, has four or five inches of reasonably good topsoil over fairly stiff clay and, in some parts, ironstone. Most of the farm lies wet in winter and only part responds to plug draining. Ironstone precludes mole draining on some parts which could never be described as being naturally very fertile.

In 1945, when improvements were first really started, the property was running slightly fewer than 2,000 ewes, fattening the lambs, and fattening 150 to 200 head of bullocks. A few years before this, the ewes had been down as low as 1,500.

There was no fixed programme to begin with, and two-thirds of the farm was still in stumps and logs. Attempts had always been made to stump a new era every year, but it was a slow, heart-breaking job with horses and stumping jacks as the only mechanical aid. In 1945, a tractor of medium size was bought, but even with this the job was far too slow and the area could never be covered sufficiently rapidly, so the following year a bulldozer was engaged. The bulldozing was a most successful venture, and between 20 and 30 acres were ploughed on which swedes and choumoellier were grown. This was soon discovered to be all the forage crop required, so some other programme had to be found to speed up development.

In the late autumn of the following year (1947), the services of some excellent contractors were obtained, and with them 80 acres of wheat were grown for two years on a share basis. It was estimated that, because of the previous meagre improvements, the same amount of stock could be retained, but, unfortunately, the following autumn was very dry and the number of ewes had to be reduced to about 1,900, from which about 2,000 lambs were docked. Also, the fattening and selling of bullocks did not improve the financial position. At the same time, too, the bank manager had a look over the farm and, while sitting on a log with rushes over his head, announced that he thought the position was hopeless.

However, there was no turning back—prices were all in our favour and the contractors knew their job. After sowing the first 80 acres in grass, they were persuaded to continue. After eight

Before stumping was carried out.

years, three-quarters of the property had been covered and the remainder had all been ploughed at some stage, even if some of it was before World War I.

The question has often been asked whether the wheat growing paid. The answer has usually been that it did not, but the point is that the overall result certainly has paid.

Production Stage 2

In the spring of 1951, for the first time, 3,000 lambs were docked, and by early January 2,500 fat lambs were drafted off their mothers at an average weight of 38.68 lb. The remainder were fattened without difficulty with the help of a rape crop. The wool clip reached 73 bales, which gave considerable encouragement. In the autumn of 1952, rams were put out with slightly more than 2,900 ewes, and in the spring 3,450 lambs were docked.

In the autumn of 1952, it was realized that only five ewes per acre were carried on the best pastures and as many as four on pastures that had been sown down for 30 years. Consequently, at the Massey Sheepfarmers' Conference that winter, Dr C. P. McMeekan was consulted. He was very helpful, and considered it should be possible to produce at least 200 lb of fat lamb to the acre.

The following autumn, 260 acres were put aside as a trial area which was run completely separately for three years on a system somewhat similar to that advocated by Dr McMeekan.

The first year was an unqualified success. Thirty rams were put with 1,531 ewes, and 1,904 lambs were docked. These fattened well and produced 248 lb of lamb per acre. This block was some of the best of the country and most of it was sown in grass during the previous three or four years. The area was chosen for numerous reasons, but chiefly because it was considered that if success was not achieved there, it would not be achieved on any other part of the farm.

The second year was poorer, with production only about 220 lb of lamb per acre. This was due chiefly to a much poorer lambing percentage.

The third year was better than the second, with 230 lb of lamb per acre—achieved partly by putting on more ewes. As the summer was dry, there was a large number of old thin ewes, but, luckily, the market for fattening ewes was quite good. The ewes in this trial were all aged from five years upwards. Old ewes have always been run on the farm, and a proportion have always been kept for more than one year. The wool clip averaged 55 lb per acre for each of the three years.

The conclusions reached were:

(1) It was quite plain that carrying capacity could be further improved.

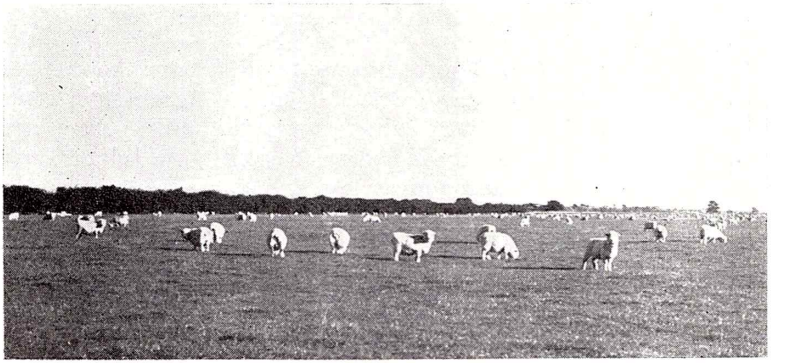
(2) The same carrying capacity could not be expected over the remainder of the farm, as some of the best of it had been used for the trial.

(3) The flock management, which was rotational grazing up to lambing, did not give complete confidence, though the management system worked satisfactorily at Ruakura, which was visited on three occasions.

(4) Very wet conditions in mid-winter, when the flock was grazing on slightly more than half of the 260 acres, caused excessive pugging.

(5) The saving of pastures for two months to give the ewes a much higher plane of nutrition for the last month before lambing appeared to depress clover growth, and, in fact, the clover on the trial area was reduced greatly over the three-year period.

(6) Cattle were used as required to control surplus growth. Actually, the area fattened 50 bullocks each year. No attempt was made to estimate the beef production per acre. However,



Typical cleared paddocks.

not nearly the number of cattle was required as compared with the rest of the farm. Buying cattle in spring and selling in autumn has normally been anything but profitable. In 1956, the last 100 head sold showed a loss of £1,000.

Production Stage 3

The question now was where to go from here? Over the farm it had not yet been possible to achieve more than 180 lb of lamb per acre. The cropping programme had finished and the gradual disappearance of clover was a worry. Should a new programme of cropping be started and should forage crops be grown on the poorer paddocks?

Eventually, it was decided to attempt the following:

(1) Leave the plough in the shed.

(2) Persuade F. E. T. Suckling, of the Grasslands Division, D.S.I.R., who had been taking an interest in the problem, to carry out some fertilizer trials on the property. The Te Awa hill pasture research area, where carrying capacities equalled those on the farm flats, was also carefully inspected.

(3) Buy a haymower to avoid having to use so many cattle (in one or two years 500 head had been bought) with the hope that hay could be made which sheep would eat in the winter.

(4) Try to work out a system whereby the advantages of both rotational grazing and set stocking could be utilized. The aim was to set stock in the winter until weaning and rotational graze or mob stock to clean up pastures in the summer and autumn, as is practised on the Te Awa hill pasture research area.

What Success Has There Been?

In the autumn of 1956, rams were put with $5\frac{3}{4}$ ewes per acre—the idea being to reduce the ewe flock by mid-winter to 5 per acre, by ram raddling and culling. The hay was poor and the sheep not very enthusiastic about it. However, a reasonable winter was scraped through without too many losses. A total of 5.9 lambs per acre was docked—a low figure and below average even though lambing percentages were generally poor in the district that year.

The autumn of 1957 started badly. Feed was short and the annual facial eczema scare necessitated the whole flock being closely confined for a fortnight with poorish hay as its only ration. Some of the bought-in ewes suffered most. Within a day or two of the flock being released, rams were put with 100 fewer ewes than in 1956. The feed position was not good, and it deteriorated as winter advanced. At no stage did the pastures look virile. The hay reserve had been considerably depleted during the facial eczema scare. The ewes were set-stocked early in June and hay feeding was started over the whole farm in mid-July. Sleepy sickness appeared almost immediately, bringing serious trouble, but there was nothing that could be done about it. More hay was bought and the ration increased, but it was of no avail—$3\frac{1}{2}$ per cent. of the ewes died from sleepy sickness alone, but from lambing onwards losses were very light. Actually, more ewes were shorn in early January than in the previous year, and 6.3 lambs to the acre were docked, which was much better than had been hoped.

After docking that year, some serious discussions were held with Mr Suckling. The fertilizer trials had begun to show some results. In the first set of trials, the only fertilizer to give any practical response was superphosphate and superphosphate alone. This finding has been borne out by a further group of exhaustive trials. Remarkable responses have been given by applying up to 8 or 10 cwt of superphosphate per acre. This is quite unusual. As a result of these fertilizer trials, a 35-acre paddock was topdressed with 6 cwt of superphosphate per acre. The results shown in the small plots were repeated on a paddock scale and marked increases in grass growth and stock carrying capacity were seen. It had been the practice up to that time to spread 2 cwt of superphosphate per acre each autumn and 10 cwt of lime every third year.

In discussions with Mr Suckling, attempts were made to upset his set-stocking system, but he was not easy to upset. As a result of these discussions, 2 cwt more superphosphate was spread that

spring, and this has now become regular practice. The set-stocking system has also been continued, though the plough came very close to the shed door.

Whether it was the superphosphate or not, the sheep did well that spring and early summer, and for the first time the whole farm produced slightly more than 200 lb of lamb per acre.

In the autumn of 1958, the farm was stocked at the rate of six ewes to the acre. The hay was better, the annual facial eczema scare was of shorter duration, and the autumn was considerably better from a feed point of view. The ewes started the winter in far better order. The hay feeding started a little earlier and the ewes were fed in fairly big mobs on the drier country. Gradually, the non-hayeaters were shed off and set-stocked at an average of about 5 per acre. As a few cases of sleepy sickness started to show up, various types of concentrates were bought, and from these one was chosen that the ewes liked and which was stable enough to scatter on the ground. This concentrate was fed at the rate of 1 oz per sheep and gradually increased to 3 oz just prior to lambing. It cannot be said that no more sleepy sickness occurred, but it never became serious. How much the concentrate helped can only be a guess, but at least it kept the ewes interested in living. The feeding of concentrates sounds costly, but by the time feeding started the number of ewes actually being fed was decreasing until, just prior to lambing, the number was down to 1,000. A little more than 2 tons of concentrate was used at a cost of about £90. By now the grass was growing and lambing went well, with a record low ewe loss over the lambing period of 1 per cent. Eventually, 6.9 lambs per acre were docked. Looking back on that winter, it was judged a worry, but a success.

Everything looked well, but the weather had not been taken into account. It forgot to rain and the farm dried up much earlier than usual, and in mid-November, 1958, there was barely sufficient grass for the sheep and practically none for the expensive cattle. Consequently, by early January, 500 fewer lambs than usual had been drafted and, having docked 500 more, this meant that there were 1,000 extra to fatten at this stage. However, rain had started in early December, just after the cutting of the precious and jealously guarded hay crop, so that there was no lack of grass. The lambs fattened with a lot less difficulty than had been anticipated. Also, although the first hay crop was lost, rapid grass growth enabled the best hay to date to be made later. The lamb weight for this year rose to 210 lb per acre and the wool off the ewes to 52 lb per acre.

Each year the practice has been to take all the wether lambs off a brother's hill country farm, the number varying between 550 and 750. This year it was 735, all of which were fattened, except for the tail-end which will be used for farm meat. These bought-in lambs have not been included in the production figures.

Further Farm Management Problems

Drainage

Like most of the Manawatu, wet land is one of the major limitations to farm improvement.

In this particular case, the farm is still far from well drained. The best that can be said is that most of the worst areas have been improved. Over much of the area, plug draining alone is waste of time, as there is either too little fall or too much metal and/or ironstone. The outlets are generally not very good. To be able to make the best use of plugs, it is necessary to use a lot of pipes across the fall, and this requires a high degree of accuracy. The stony ground also needs pipes for which a back-acter type of drain digger is required. Fortunately, it has been possible to make use of the Massey College Drainage Extension Service.

It has also been noted that the higher the stocking rate the more apparent the wetness tends to become and the more precautions must be taken to prevent pugging.

Diseases

The two diseases which give the most alarm, and the only two to be mentioned here, are salmonella and facial eczema.

Salmonella has been present for four months recently and accounted for some 3 per cent. of the ewe flock. It was fortunate that more were not lost, as there were no effective weapons with which to combat it. The veterinarians always advise spreading sheep out. When it broke out this year there were 10,000 sheep on the farm, and even had these been spread out, they would still have been running at the rate of 12 to the acre. An attempt was made to keep the disease isolated, but this was only partially successful.

As for facial eczema, it is felt that, for many reasons, the more intensive management becomes, the more likely it is that stock

will be lost, directly or indirectly, from facial eczema. Farmers are now a lot happier about recognizing what sort of season, and what sort of weather within that season, is likely to produce economic loss over a district from this disease. But, until there is some management alternative to shutting up, there will never be a good individual response to warnings. The Grasslands Division copper spraying trials of recent years give hope that a stage might be reached where sheep could be shifted rather than shut up. Regarding this as a problem in husbandry more than anything else, it is hoped that such experiments in field control will be given every help and encouragement.

Losses from diseases and other misadventures over the last four or five years have averaged almost 8 per cent. of the ewe flock annually. This is high, too high, but the ewes are old and reasonably cheap.

Cropping

As stated previously, two-fifths of the farm is brown shingle with only an inch or two of topsoil. In the original improvement programme, it was possible to grow surprisingly good crops, particularly of swedes, and, in the main, these areas were ideal for feeding-off in the wet winters. Difficulty had been experienced in establishing a permanent pasture after the crops. For the first two or three years, the pastures look and perform well, but from then on deteriorate rapidly. This is quite natural, as the inch or two of fertility built up over the years has been buried and the surface is shingle. The initial deterioration has often been speeded up by the grass grub, but the heavy stocking and consequent tramping, plus the feeding of hay, have given an amazing improvement of the pasture.

No doubt a number of farmers will say the expense of cropping is not excessive when compared with the cost of making hay, storing it, and feeding it out again during the winter. On the other hand, a lot of the expense of haymaking, etc., is offset by the fact that, in the main, only surplus grass is used, whereas otherwise extra cattle would be needed to deal with it. However, the amount of capital involved in the purchase of cattle makes them a poor risk unless they are wintered.

There can be few things worse than trying to feed-off crops with large numbers of ewes in a wet Manawatu winter.

PASTURES

During the original breaking-in of the farm, the aim was to obtain a predominantly ryegrass/white clover pasture. The mixture used was similar to the following: perennial ryegrass—25 lb, H.1 ryegrass—10 lb, white clover—4 lb, red clover—2 lb. The seed was the best procurable, but the mixtures did vary at times. For instance, on some of the shingle country, a certain amount of cocksfoot was sown, often including dogstail and sometimes suckling clover. This mixture is not particularly recommended; it is merely a statement of what was done.

After the trial, using what had become known as the "McMeekan system", it was decided that the autumn saving of pasture encouraged browntop, Yorkshire fog, *Poa trivialis*, and moss. It also had the effect of depressing clovers, whereas experience on the farm has been that the more clover, the better the lambs fatten. The conclusion has been reached that more consistent grazing in winter—in other words, set stocking—is inclined to depress the unwanted species and encourage clover.

The most difficult period with the grass, other than the one between early July and mid-August, is between mid-November and early December. This is the time when perennial ryegrass runs up to seed and the lambs almost invariably receive a check. This is a problem to which no answer can be advanced, even though various practices have been tried. Grasslands Division suggests that the answer may be some type of mower which will prevent the ryegrass from seeding, encourage tillering, and so keep the pasture palatable, or else use a more palatable perennial ryegrass—when they get it.

H.1 ryegrass with clovers has also been used on about 100 acres, but its persistence has been disappointing, due, quite possibly, to poor management. In some respects, however, it has proved to have excellent qualities. Ewes and/or lambs have done well on it at any stage of growth and will keep doing well at a much heavier rate of stocking than is the case with perennial ryegrass/white clover. For example, this last autumn more weaned lambs have been fattened on grass than ever before and they have been more or less set stocked on about 100 acres of H.1 at a much heavier stocking rate than those on other pastures. At each draft, the lambs on the H.1 have been considerably better than the others, even though the H.1 has very largely run out except on about 25 acres which have been sown down more recently.

This development story is typical of many other farms, and this attempt to sum up logically the pros and cons is handicapped at the start by the knowledge that the work has been done, to a large extent, because of the pleasure of doing it.

However, there are some logical arguments. The development to 6 ewes per acre on this class of country is not recommended to anyone who wants to sleep well every night or who has not got a benign bank manager. It is not just simple arithmetic. It is a lot harder going from 5 ewes to 6 than from 3 to 4. Nor can it be recommended to anyone looking for a 40-hour week. In fact, from the point of view of ease of living, it is just plain silly.

But it has certain advantages. There is now, financially, a much stronger unit than before. The capital set-up of land and building is now spread over more than twice as many sheep, and capital improvements already made would maintain the farm for a while if times got really tough. In addition, the position is being reached where economic units for the children can be provided.

In this way there is the satisfaction of feeling that trusteeship of this bit of soil—to the family and the nation—is being justified.

That introduces the final problem which is common to all farmers—death duties.

Sheepfarm products provide roughly two-thirds of the national income. To feed the expected population by 1975 and to maintain the export income, the nation is looking to farmers to increase production by at least 50 per cent. There are only some 22,000 farmers who care for 86 per cent. of New Zealand's sheep and from whom the greater part of this increase of sheep products must come. In meeting their responsibilities to the nation, these sheepfarmers will engage in farm development programmes which do not bear fruit tomorrow but which extend through the farmer's lifetime to those who follow him. Apart from threatening the continuity of farm ownership, the present level of death duties means that, in every generation, 30 per cent. of the capital represented in the average sheepfarm must be drawn out to pay death duties.

It has been shown by the agricultural statisticians that, to increase production by $2\frac{1}{2}$ per cent. each year, the sheepfarmer must spend $12\frac{1}{2}$ per cent. of his gross income on capital expenditure yearly.

In the case of the farm discussed, this means increasing capital by nearly 40 per cent. in the next 20 years, 60 per cent. of which will be required for death duties.

Urban businessmen suggest that they are in the same position, but, of course, this is not so. Farmers require twice the capital to return the same income as businessmen receive. The sheep-farmers' average return is 5 per cent. before paying taxes, and at the present time probably less. What businessman would start a business if he could not see 10 per cent.?

This lack of political vision fails to encourage agriculture and prompts the question, "How serious is the nation about maintaining the standard of living of tomorrow's population " and to those farmers who go ahead developing regardless, "How silly can you get?"

Acknowledgements

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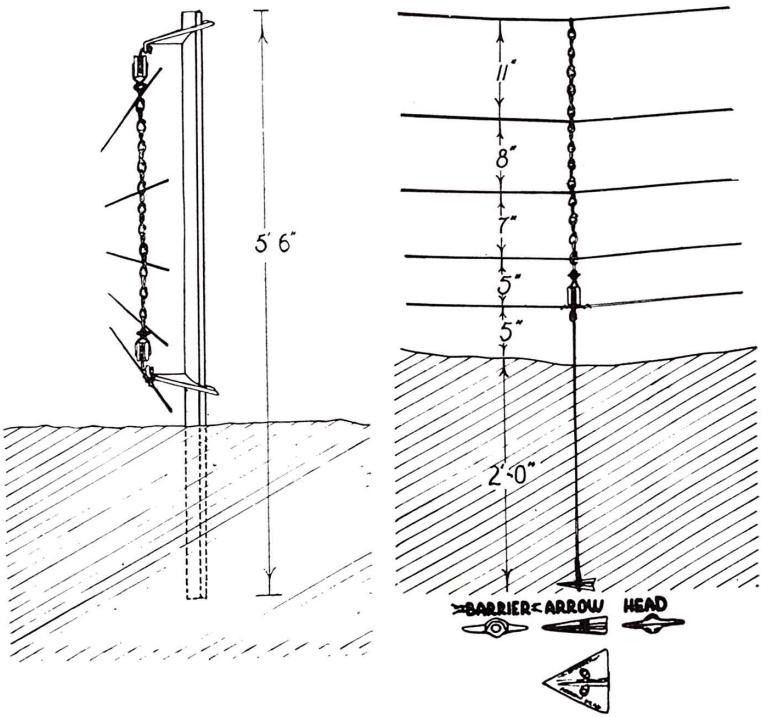

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C.1. Grass Grub and Porina Caterpillar.
C.2. Armyworm.
C.3. White Butterfly, Diamond Backed moth.
C.4. Cabbage Aphis.
C.5. Crickets.
C.6. Potato Tuber Moth.

E = EQUIPMENT

E.1. Howry-Berg Duster Reminder on operating checks.
E.2. Microsol Model 202 Reminder on operating checks.

G = GENERAL INFORMATION

G.1. Dosage variations for TARTAN Concentrates applied with different sheep spray races.
G.2. Sheep dips and concentrates—Selection chart.
G.3. Bath dipping table—Amounts required.
G.4. Spray dipping table—Amounts required.
G.5. Positioning the Howry-Berg duster in sheep yards.
G.6. Pest Control inside buildings using Microsol.

L = LIVESTOCK

L.1. Internal Parasites of sheep.

P = PRODUCTS

P.1. Aldrin Bath Dip.
P.2. Aldrin Spray Dip.
P.3. Dieldrin Bath Dip.
P.4. Dieldrin Spray Dip.
P.5. L-K Bath Dip.
P.6. L-K Spray Dip.
P.7. Dieldrin Sheep Dust.
P.8. Procall Dust—Use on Livestock.
P.9. Procall Dust—Use on Crops.
P.10. Dieldrin Sheep Spray Concentrate.
P.11. Aldrin Sheep Spray Concentrate.
P.12. Dieldrin Blowfly Solution.
P.13. Fenodren—Liquid Phenothiazine.
P.15. D.D.T. Prills.
P.16. Aldrin Prills.
P.17. Cobalt Prills.
P.18. Molybdenum Prills.
P.19. No bulletin at present.
P.20. 2, 4, 5-T Free Acid.
P.21. 2, 4, 5-T Butyl Ester.
P.22. 2, 4, 5-T Butoxyethanol Ester.
P.23. 2, 4-D Free Acid.
P.24. 2, 4-D Butyl Ester.
P.25. M.C.P.A.
P.26. M.C.P.B.
P.27. Dalapon and T.C.A.
P.28. Footrot Dressing.
P.29. Cobalt drench.

W = WEEDS

W.1. Weed Control table.
W.3. Clover damage by Hormone Weedkillers.
W.4. Weed control in Cereal Crops.
W.5. Control of Gorse.
W.6. Control of Blackberry.
W.7. Control of Sweet Briar.
W.8. Control of Ragwort.
W.9. Control of Californian Thistle.
W.10. Control of Variegated, Scotch, Nodding, and Winged thistles.
W.11. Control of Spurrey (Yarr).
W.12. Control of Rushes.
W.13. Control of Barley Grass.
W.14. Control of Fathen.
W.15. Control of Buttercups.
W.16. Control of Docks.
W.17. Total destruction of Turf.
W.18. Weed Control in Lucerne.
W.19. Control of Redroot.

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F.C. 16

SPACE PLANTING FOR EROSION CONTROL IN COASTAL HAWKE'S BAY

H. M. WILLIAMS*

THE TERM SPACE PLANTING may need some explanation. It is a term used in soil conservation work to mean planting trees to try to stabilize the soil. This work can be done with any trees and either with or without fencing. In the present case planting was done without the costly item of fencing and the only trees used were poplars and willows.

The property is on the east coast of Hawke's Bay in the Patangata County. The original ground cover was bracken fern with small patches of manuka and some light bush in the gullies.

Soil

The soil types are very mixed, being made up of various bentonitic clays and clay loams, in places overlaying papa and rotten rock. All these soils are very prone to slumping. An estimate of the amount of original turf left was as low as 30 per cent. This does not mean that the balance is bare earth; grasses re-establish themselves quite readily, especially when superphosphate is applied.

The New Zealand Geological Survey, D.S.I.R., states: "A high grade bentonite may absorb nearly five times its own weight of water, and at full absorption may increase its volume up to fifteen times its dry bulk". In dry weather it is common for the soil to crack along the line of sheep tracks. After rain water can then pour down these cracks and begin an earth movement. This movement might not be great at first, but the soil might remain in this position for years before finally slumping or slipping right away.

Rainfall

The average annual rainfall in this area is about 55 in. and, like most of New Zealand, the greater part of the rain falls during the winter. A most peculiar feature, shown by the monthly rainfall figures, is that the wettest and driest months both occur in the summer. Over 14 in. of rain fell in February, 1936—this figure was only exceeded by a total of 16 in. for April, 1938. At the other extreme, in February, 1946, not one point of rain was recorded.

Rainfall intensities can be very high in this district—the heaviest recorded was 0.95 in. in 50 minutes. A neighbour, nine miles away,

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recorded 13.50 in. in eleven hours in January, 1953. This storm damaged the fences so that the property was virtually one paddock and also open to the neighbours.

Cuttings

The best sized cuttings of willow or poplar to raise in a nursery would be no thicker than a pencil and about 4 to 6 in. long. In general terms, the larger and older the material the more difficult it would be for the cutting to take root. One of the most important points in preparing poles is to see that all twigs and branches are neatly trimmed off close to the main stem.

Planting material can be divided into "wands"—1 to 1½ in. in diameter and up to 9 ft long, and "poles"—2 to 6 in. in diameter and 9 to 10 ft long. The best quality poles are cut from stump re-growth and anyone contemplating planting and not having a ready supply of material would be well advised to establish a nursery on a handy site. If possible, this should be on a piece of rich alluvial soil. This re-growth from stumps is far better than branches cut off mature trees. Such branches are brittle and often not straight. Growth from this type of pole may start lower down, where side branches have been trimmed, instead of at the top.

The sooner cuttings are planted the better, but poles can be left on the ground longer than wands; the latter will soon dry out and fail to root.

If there is any likelihood of delay in planting or where a large number of trees is to be handled, it is a good plan to put the butt ends of the wands or poles into a dam. This will result in the pole shooting at an earlier stage than normal. Roots will soon begin to develop in the water, but will wither off if not planted at once.

Most of the planting has been done with poles using, for preference, a pole of 2 to 3 in. diameter and about 9 to 10 ft long. These are quite strong but not too heavy. The larger sizes, up to 5 or 6 in., are too heavy to carry, not so reliable to grow, and also the large cut surface at the top may allow rot to set in.

The smaller wands are easily broken by sheep passing in mobs, even after being established two or three years, and wands do not have such a good grip on the ground and easily become loose in the summer.

Species to Use

One of the troubles at first was to get a sufficient number of poplars. Plenty of good willows were available from the river bed and were no problem, nor were so many of them needed.

The only poplar which could be obtained in any quantity was the Lombardy poplar. It will exist under very dry conditions, does not shade the pasture, and roots easily. When planted near permanent water, the roots will stop at the water level. Moreover, these trees, once established, will soon dry out damp places and consolidate the ground.

A species of poplar, thought to be *Populus deltoides*, will grow well in wet situations where willows would thrive. This species was tried without much success, but the only poles available were cut from old trees, which had been felled. It is believed that the Hawke's Bay Catchment Board have had good results from this tree using re-growth from stumps.

The Catchment Board conservator suggested that silver poplar be tried in some of the very bad places. Undoubtedly it will quickly establish itself by its habit of suckering. Stock and opossums do not eat it very readily, but so far it has not been used because it can easily take charge and almost become a weed.

The first poplar poles were obtained by driving along a single row windbreak with a truck across the deck of which was a diving board arrangement on which a man stood and was able to lop branches without any trouble. This may sound rather a hazardous arrangement, but no one was killed or injured while cutting some thousands of poles.

The Catchment Board later found a much better and almost unlimited supply from the local orchards. Many orchardists with Lombardy poplar windbreaks like to cut them back periodically. This work can now be carried out and furnish quite a useful return from the sale of poles. The quality of these poles is excellent, as they are strong, with very little branching and not much taper.

The golden willow is regarded as one of the best for erosion planting because of its very strong root growth. It often fails to take root where there is no permanent water. The crack willow has been found much better for hillsides and streams which dry out in summer.

Planting

Planting can be started in the autumn, provided there is sufficient moisture in the ground, and can go right on to early October. Lombardy poplar has been planted in the first week in October when the trees were in leaf and 98 per cent. struck. The planting was on a southerly face and the aspect in this case was an important factor. Willows can be planted at almost any time of the year so long as there is sufficient moisture in the ground.

Ordinary fencing spades were used for digging holes at first, but soon it was found that 2 ft and even 2 ft 6 in. was not deep enough. Finally 3 ft was chosen as the best depth—not because the poles root any better at this depth, but purely on account of the added stability in the ground. It is very difficult to dig a hole 3 ft with a spade, so a No. 2 spade was fitted with a shovel handle and the blade bent in a curve from $7\frac{1}{2}$ in. wide to $6\frac{1}{4}$ in. Not only can holes be dug with these bent spades more quickly and with less effort but it is possible to dig a much smaller hole. It is not necessary to plant the pole absolutely perpendicular. On a hillside it is easier to dig the hole at a slight angle, and the earth can be lifted with less trouble. With the pole being set at a slight angle, cattle will be unable to reach the branches at the top.

The actual site of the hole is also important. If possible, choose rough or broken ground in preference to smooth turf as sheep will be less inclined to rub or nibble the bark.

It is not absolutely necessary to clean out the last of the loose earth at the bottom of the hole. The pole should be driven hard into the bottom of the hole so that it is quite firm and resting against one side of the hole. When the soil is very wet, it is impossible to do much ramming, but the job can be made reasonably firm by finishing off with a sod of turf at the top. If clay is used at the top it will dry out and crack in the summer and leave the pole quite loose. It is also a good idea to leave a slight depression to finish off; this will help to collect light rain in the summer.

It is preferable to concentrate planting on the top and bottom of an earth movement and not bother so much with the middle. An occasional willow is used where there is any sign of water which may have started the slip.

Along water courses, especially where there is a sharp fall or any sign of scouring, willows are planted in pairs.

No one can forecast where ground is going to move unless there are cracks to indicate where a slight movement has already taken place. The steepness of the slope is not always an indication of possible slumping. After a prolonged spell of wet weather, when the earth is almost flowing, slumping will take place on an 8° slope (which is approximately a grade of one in seven). Plenty of instances are known where, even with well established trees, the ground has begun to move again and gone right to the bottom of the slope. In some cases it has been possible to save the ground with denser planting. However, there seems to be a certain amount of luck in the first few years before the trees are well established.

In one paddock, planted first in 1948 only in places which appeared likely to slip, it has been necessary to go back several times later to fill gaps where fresh slips have occurred. It seemed as if it might have been better to have gone ahead and planted the whole paddock at first. This was suggested to the soil conservator for the Catchment Board and he agreed to try planting a whole paddock and a plan worked out to plant a 90-acre paddock with about 3,000 trees. Where there appeared to be less chance of movement trees were spaced widely and the spacing was tightened up in the bad places. A density of 435 to the acre (or spacing about 10 ft apart) was laid down. On the wider plantings 15 to 35 to the acre (35 to 45 ft apart) were made.

Unfortunately a track giving access to about half the paddock was completely blocked by a slip with no hope of clearing it. A helicoper was suggested as a means of transport instead of a fixed-wing aircraft, as the airstrip was further away from the job, and the dropping site would also have involved some rather tricky flying. The cost per wand was slightly cheaper on this job than another one using tractor transport. Transport, by the way, is always difficult once the ground is really wet, even with a crawler tractor. After several trips along the same track it can become impassable.

A good deal of preliminary work was involved in using the helicopter; special release equipment had to be made and fitted. The wands (9 ft long by 1 to 2 in. diameter) had to be bundled and weighed—a 200 lb pay-load of about 160 wands.

The actual flying operation was very successful and 1,600 wands were landed in 40 minutes. The results of the planting were not so good. The bundles were not stood in water in case this affected their weight, and the best that could be done was to

keep them in the shade under wet sacks. It takes quite a long time to plant 3,000 trees, even when they are on the job, and perhaps some of the sticks were too dry before they were planted. It was unlucky that there was a very dry summer on top of all these troubles. Those trees which were planted early and had not lain for long survived even on the driest sites.

Costs and Management

Table 1 shows the total cost for seven years; in most cases this was covered by a £1 for £1 subsidy from the Soil Conservation and Rivers Control Council.

In some cases a portion of the planting was on £2 for £1 basis, where it was classed as creek control. The wide difference in the years 1950 and 1951 is an example.

Between the years 1942 and 1948, no accurate tally of poles was kept, but it is esimated that at least another 3,000 were planted.

The chief reason for starting this work, quite apart from erosion control, was the need for protecting fences. It was obvious when cultivation and pasure improvement was begun that any subdivisions would be impossible without first holding the ground. Good work had been done after World War I with willows planted along the main creek banks. Planting in 1942 was begun in an effort to save a fence from being carried away and some planting or dam work has been carried out nearly every year since then. The Hawke's Bay Catchment Board was formed in 1944, but no work was carried out on the property under their subsidy scheme till 1948.

TABLE 1: Costs of Planting Trees.

Date	*No. of Trees*	*Cost per Trees*
1948	600	1s. 11d.
1949	2,690	1s. 10d.
1950	500	1s. 2d.
1951	560	2s. 6d.
1952	300	1s. 4d.
	986	1s. 10d.
1954	1,500	3s. 2d.
1957	3,000	2s. 6½d.
TOTAL	10,186	AVER. 2s. 5d.

Stock Management

Cattle should be kept out of paddocks which are planted for at least a season or two. Grazing with cattle can be undertaken with care between leaf fall in May till new growth begins in September. Once a tree has made its season's growth, say after mid-summer, any damage to shoots is not very serious. Young cattle and horses are likely to eat the bark of trees. On one occasion in the spring twelve yearling cattle were put into a small paddock in which there were a few young willows. The trees had been well painted with creosote, but within a week there was no bark left on any of them—all this in spite of the cattle being knee deep in grass.

Since mob stocking of the ewes has been practised, pasture control has been a great deal easier. It is not suggested that this is perfect grazing, but provided not too large a proportion of the total acreage is to be treated in this way it can be managed. At present there are three paddocks (two just over 70 acres, and one over 90 acres) which have had no cattle for two seasons.

By far the biggest problem is the opossum, which has a habit of eating one particular tree till there is nothing left. This accounts for a lot of deaths in the spring, particularly amongst young trees.

Phenothiazine tins have been experimented with as a form of protection against opossums, where a few trees are needed to protect a fence line. Any round tins of this size, 7 in. × 8 in., could be cut top and bottom in the form of a cross and pushed down over the pole. There is not much wind resistance and the tin, being tight, does not chafe the bark. Two or perhaps three tins stapled half way up a pole would prevent opossums climbing to the top.

Others who have been doing any planting of trees whatsoever feel frustrated at the damage that is being done by opossums. The only way to deal with the opossum is on a national scale. The sooner opossums are put on the same basis as rabbits the better.

A long-term policy of improvement could be carried out by space planting with poplars on country which is too steep for any form of cultivation. No one would question the value of work done to save soil from going out to sea. Besides soil erosion there are two other aspects worth considering. Space planting will give some protection from strong westerly winds—in a dry season the

East Coast often suffers more from drying winds than actual lack of rain.

Most people would laugh at the idea of willows providing much shelter in a southerly storm for freshly shorn sheep. The storm last October, in which so many thousands of sheep died, provided a striking example of the shelter these trees can give. After the storm places were found all along the creek where the sheep had huddled under the trees and blackened the ground. It is certain that more than three out of a mob of 1,200 freshly shorn hoggets would have been lost if it had not been for that bit of extra cover.

In addition the leaves dropped from the trees over a long period of years must surely build up the humus in the soil. No cheaper method of topdressing could be devised.

DISCUSSION

Q:: *How far from newly damaged trees would you expect the opossums to be?*

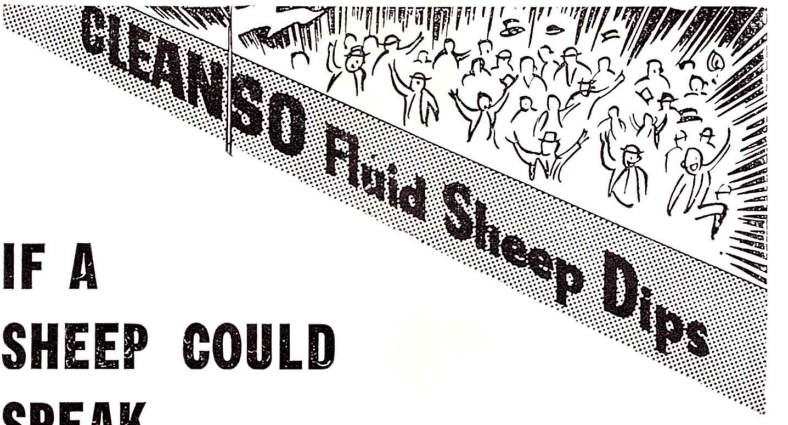
A:: Opossums travel considerable distances according to research work done in the Tararua ranges by the Internal Affairs Department. I have no information other than this.

Q:: *Have you tried raising the beds of the creeks to stop toe erosion?*

A:: Yes, but this is outside the scope of this talk.

Q:: *Is the golden willow less affected by cattle than other varieties of willow?*

A:: I have no information about cattle preference, but opossums appear to be very partial to the golden willow.



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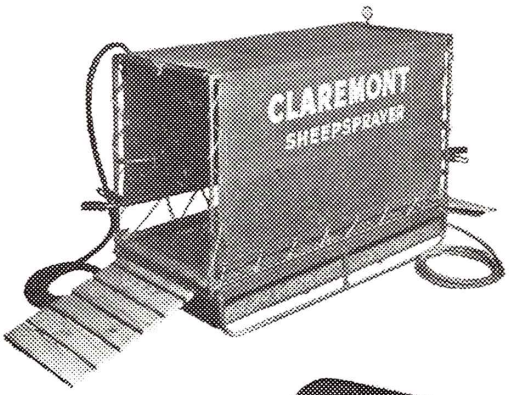

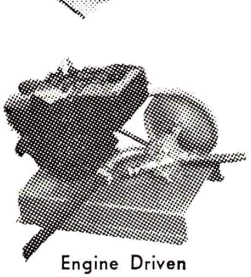

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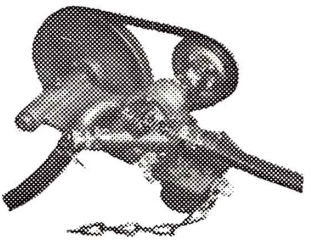

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WHAT'S NEW IN ELECTRIC FENCING?

W. R. R. HEWITT*

LAST YEAR AT THIS MEETING a series of papers dealing with electric fencing was given by a panel of speakers. Sir Geoffrey Peren, when introducing these speakers, said: "Experimental work with the electric fence on the College property in Hawke's Bay has in one year far surpassed my wildest expectations."

This year it can be reported that the fence is far past the experimental stage and is in use all over New Zealand. Not only that, but new equipment is available and on the market, and a considerable amount of work is being done on more new equipment.

This paper describes briefly the modifications the College thinks are advisable and what new equipment has become available during the year. A brief note is also given on work under consideration.

First, the College believes that a better fence would be erected using five wires instead of the four originally suggested. The College's four-wire fence has functioned efficiently, but, after discussing the matter with farmers who are now using the electric fence, it is thought that there is a case for the extra wire. The fence is more substantial to look at, and this in itself is a big advantage.

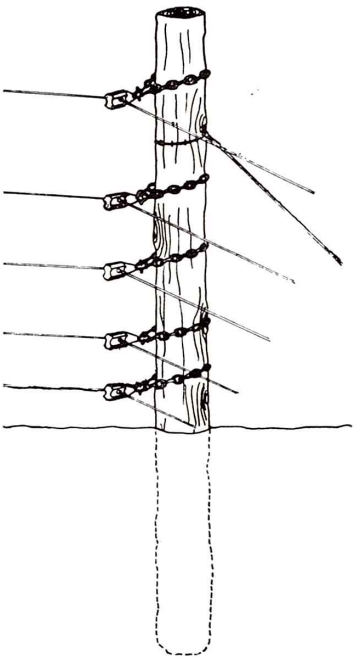
Another small point helping to keep down costs is that the long insulator costing 1s. 0d. can be used in place of the corner insulator costing 2s. 0d. at the start of the fence. It is also possible, under certain conditions, to use a standard for an angle post rather than a wooden post.

New Equipment

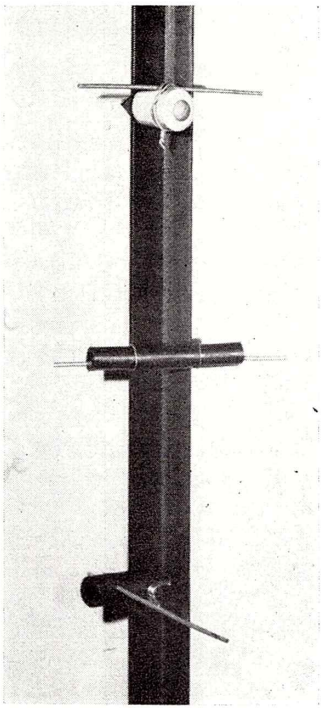
There has recently been put on the market an "angle assembly" for carrying the wires at an angle post. The cost is 3s. 0d. per unit and consists of a long insulator to which is attached, by means of a patent clip, a length of Hunter chain. The chain is slipped around the angle post and clipped on to the insulator. A staple driven into the post at the back of the angle will hold this chain in place.

The cost of this may appear high, but there is a big saving in time from the method originally used.

**Massey Agricultural College, Palmerston North.*



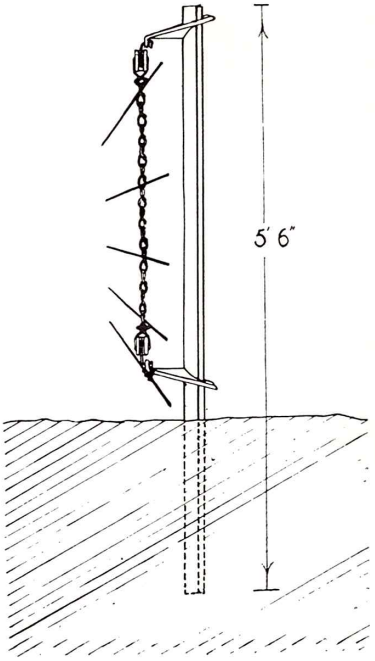
"Barrier" Angle Assembly.



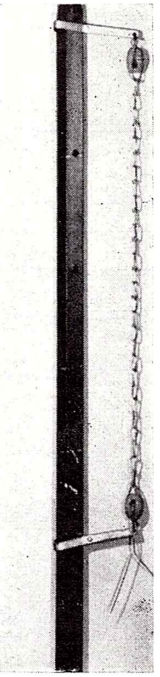
Small bobbin insulator (top), *alkathene insulator* (centre), *and Dales insulator* (bottom).

An insulator, not mentioned in the 1958 *Sheepfarming Annual*, which can be used on the standard and which is the cheapest on the market, is made by taking four inches of ½ in. alkathene tubing, splitting it lengthwise down one side, and encasing the fence wire in this and then tying it on to the standard. It has the advantage that any gauge can be used, but, so far, nothing is known of its lasting qualities over a long period of years. The cost is only 2½d. per insulator. This insulator is ideal for break feeding of crops.

A third method, recently put on the market and finding much favour with farmers, is the "insulated assembly bracket". There are two makes on the market and the principle consists of two iron brackets which fit over a Waratah standard. To the tip of each bracket, which stands out from the standard approximately 2½ in., is attached a piece of Hunter chain insulated at both ends. By



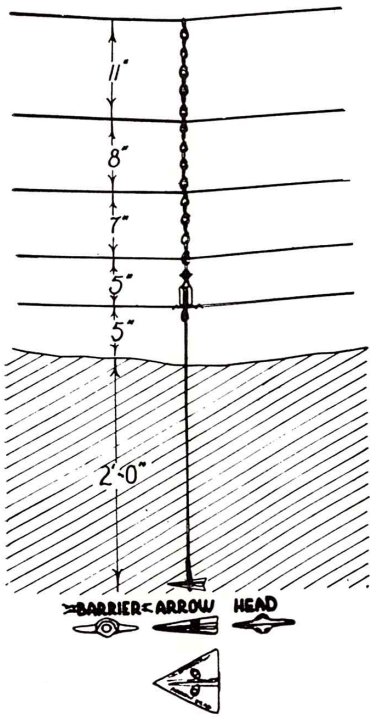
"Barrier" Assembly Bracket.



"Speedrite" Assembly Bracket.

slipping the second bracket down the standard to the fullest extent allowed by the length of chain and tapping this bracket down tight on the standard, the chain is rigidly suspended between both tips, and the fence wires can be attached to this chain by means of a Hunter clip at any gauge required. It requires only a matter of seconds to attach this fitting to the standard and has the advantages that it is absolutely foolproof, allows any gauge to be used, and is the most effective method so far developed. There is a distinct saving in leakage of power, and it is claimed that this method will double the length of fence that can be electrified. The cost is relatively high in comparison with the other method just mentioned or the small bobbin insulator, as recommended in the 1958 *Sheepfarming Annual.*

Summed up, therefore, the four different methods mentioned below are the most efficient and economical that have so far been used for attaching the wires to a standard for permanent fencing:



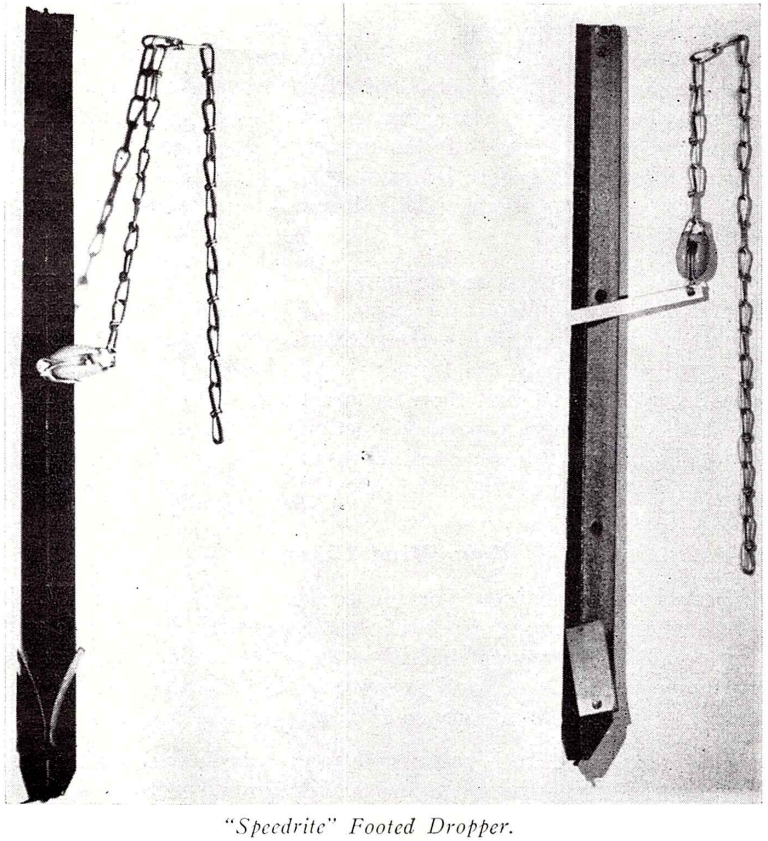
"Barrier" Footed Dropper and Arrowhead.

(1) 4 in. alkathene tubing which costs 10d. for four wires. Lasting quality not known at present. A very efficient insulator for break feeding of crops.
(2) Small bobbin insulator bolted to standard which costs 2s. 0d. for four wires.
(3) The "Barrier" assembly bracket costing 7s. 10d. This assembly is non-rusting, the long insulators are used, and the chain is marked with red paint for the gauge.
(4) The "Speedrite" assembly bracket which costs 4s. 9d. The brackets are of lighter material than the "Barrier" and the insulators used are the egg type.

Footings

Two new methods are available for footing. Both are definitely time-savers and are giving satisfaction where used. There is no digging attached to using either of these methods.

The "Barrier footed dropper assembly" consists of an arrowhead 3½ in. wide at the base, tapering down to a point, with an



"Speedrite" Footed Dropper.

overall length of $3\frac{1}{2}$ in. In the centre are two holes through which a Hunter foot wire is passed and securely tied. The arrowhead is driven into the ground by means of an iron bar which is inserted in a hole at the base and when the required depth is obtained the bar is removed. The Hunter foot wire is then pulled up, and this pressure will draw the arrowhead into a horizontal position below the ground. The fence wires are pulled down by a piece of Hunter chain which is insulated before being connected to the arrowhead foot wire above the ground. This whole assembly consists of arrowhead Hunter foot wire, Hunter chain, insulator and clips, and costs 10s.

The "Speedrite foot" consists of a 2 ft length of Waratah standard to the bottom of which has been riveted two strips of 16-gauge galvanized iron 3 in. long by $1\frac{1}{4}$ in. wide. This length

is driven into the ground at the place where a foot is required and a bracket, similar to the "Speedrite post assembly bracket", slipped over the top. A piece of Hunter chain attached to the fence wires pulls the fence down to the foot, and the chain is then attached to the tip of this bracket, being insulated with an egg insulator just before being attached to the tip. The cost of this whole unit is 7s. 6d. This foot is not suitable for sandy country.

A point which must be emphasized is that the component parts for both the assemblies for posts and foots can be purchased separately and assembled by the farmer in his own time. This will save costs in cash to the farmer, but if he adds the cost of his own labour he will find there is not much saving, if any. They are being made under mass production and the makers have the assembly down to a fine art. However, the assembly of these fittings could be a useful and profitable wet-day job on the farm.

New Wind Charger

Another wind charger is on the market. This is made by W. H. Christie, of Levin, and is called the "Speedrite". The whole unit costs £58. It charges at half the rate of the "Barrier", but requires very much less wind to drive it. The College has had this machine under trial for six months at "Rata".

Last year the College was unable to give any advice on the best method of keeping the fence line free of growth so that no shorting would take place through grass coming in contact with the live wires.

Experience at "Rata", which is poor country, is that there is no worry from grass and that a sharp shovel is the most economical method of dealing with other growth. The College has spent 2½ hours in two years on its 2½ miles of fence.

On the other hand, at the College, farming under intensive stocking conditions, it is found that the stock eat the grass right up to the fence and it never gets a chance to overgrow the wire.

There was one fence dividing a choumoellier crop from a gully. Naturally, the grass around the edge of the crop grew up and in many places was higher than the first live wire. On the wettest of days, the current was always coming through in no uncertain manner. Twenty-six wet days in May provided a good test, but no stock got through.

College experience is, therefore, that there is no need to worry about grass overgrowing the fence and causing a short-circuit under normal grazing conditions.

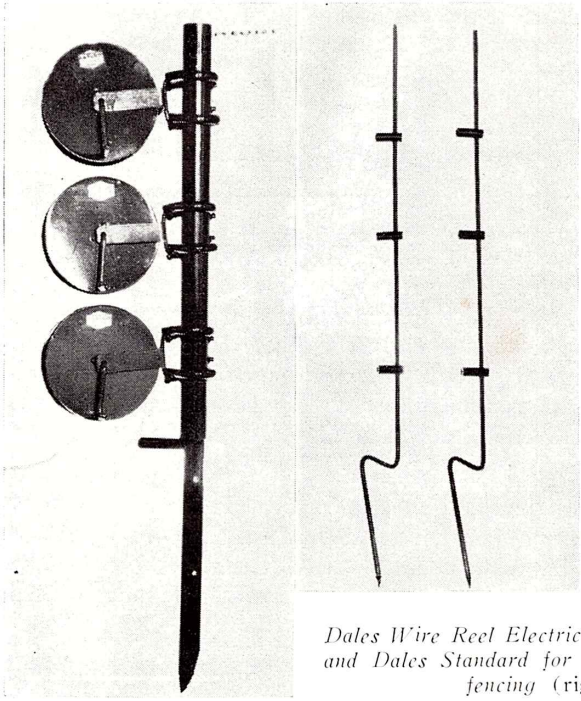
New Equipment Under Consideration

Work is being done on developing a new fence controller which, for current used, will give a marked increase in efficiency of utilization and therefore a longer life to a wet or dry battery. This is most important, because work is also being carried out on producing a dry battery which will give a very much longer life than those now on the market. One of these batteries is on trial at the College at present, and it is hardly necessary to point out the tremendous advantage that will be gained from this work if it is successful. It is known as the "Eveready Dry Battery" type 1462.

The College has found the electric fence ideal for break feeding of crops. It is far faster to erect than a netting fence, far less costly, and if a dry battery can be produced at a reasonable cost which will last for two or three months, another big advance will have been made in electric fencing.

While on the subject of break feeding of crops, it is probably not out of place here to mention that there is on the market the "Dales three reel electric fence unit" for carrying the wires—cost £8 12s. 6d.

It consists of a pipe which fits over a standard driven into the ground at the end of the fence line. Three reels, or four as required, fit over this pipe and can be adjusted to give any gauge that is required. Each reel will hold approximately 400 yd of 16-gauge galvanized wire. The wire is simply run out off the reel, attached to insulators on the standards, and a turn of the reel tightens the wires. Waratah standards can be used, in which case 4 in. of alkathene tubing will make a good insulator. There is, however, a disadvantage here, as every time the fence is moved the insulator must be untied. A better insulator (bottom insulator in Fig. 2), although more expensive, is the one the College used on its permanent fence and known as the Dales insulator. It is made by taking 4 in. of alkathene tubing, cutting a slit $1\frac{1}{2}$ in. in one end and drilling a hole right through the tube. This is pushed over the edge of the standard and a small bolt goes through the hole in the tube and through a hole in the standard. A thumb-screw nut tightens the whole fitting to the standard. The other



Dales Wire Reel Electric Fence Unit (left) *and Dales Standard for temporary electric fencing* (right).

end of the tubing projecting out from the standard has a hole drilled through it parallel with the ground, and a vertical cut from the top of the tube to the hole is also made. This allows the wire to slip down into this hole. This Dales insulator is excellent and cost 1s. 0d. complete. It has this advantage over the 4 in. slit alkathene insulator, that it can be very quickly put on a Waratah standard and the wire slips into the hole in the insulator very easily and can be just as easily removed.

There is also on the market the Dales standard for break feeding. These standards, complete with three insulators, cost 4s. 6d. and only have to be trodden into the ground.

A new wet battery will be on the market shortly. It is understood that it will cost the same as the present wet batteries used for electric fences, but will be guaranteed for five years and will be a much more reliable battery in every way.

It is obvious, then, that the manufacturers who are interesting themselves in equipment for the electric fence have not been idle during the past year, and farmers can rest assured that the efficiency of the electric fence will improve steadily.

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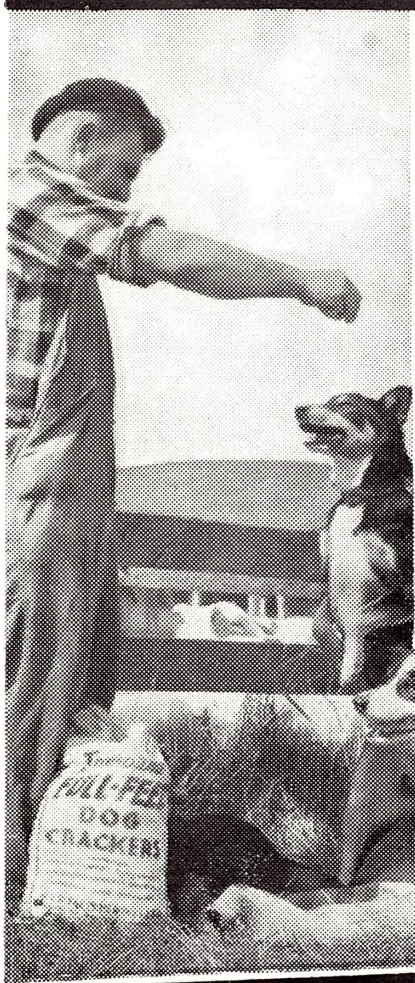

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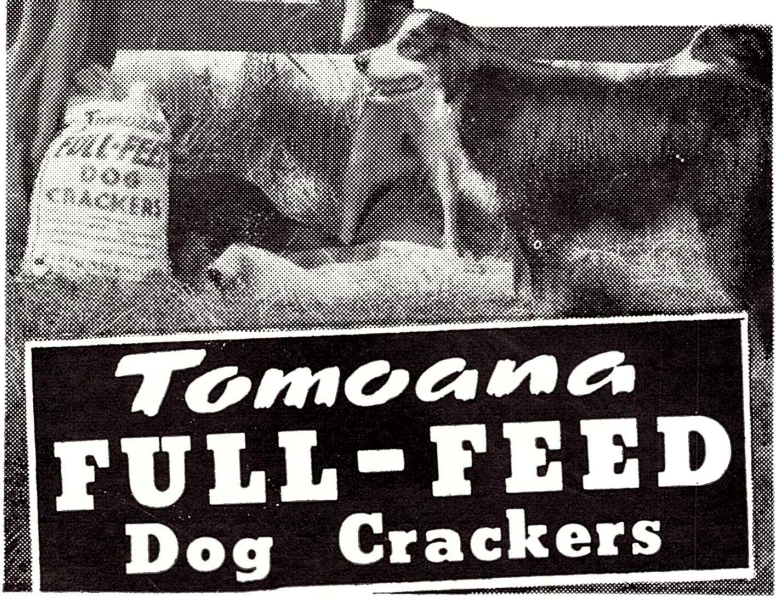

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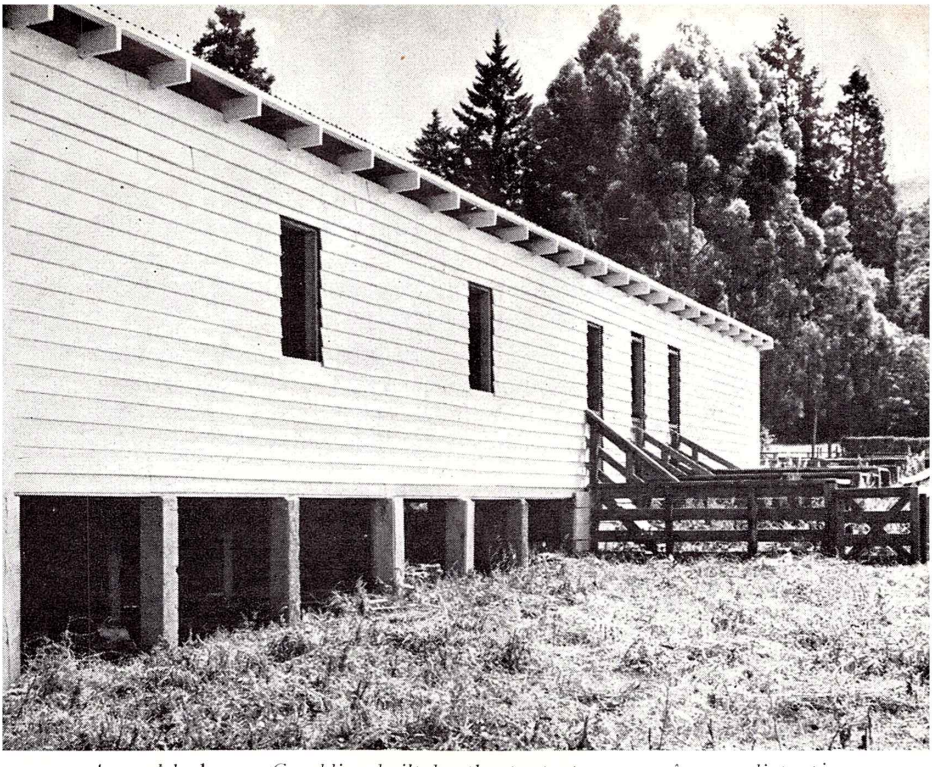

A woolshed near Geraldine built by the property owner from radiata pine and macrocarpa trees grown on the farm.
(N.Z. Forest Service photo.)

FARM BUILDING CONSTRUCTION

H. W. T. EGGERS*

THE SUBJECT OF THIS PAPER is a difficult one in that it contains two aspects—the "know how" and the materials.

It is proposed to indicate some of the large amount of information available on the "know how" and then discuss some aspects of building construction.

Before discussing buildings, it will, perhaps, be useful to discuss the functions of an engineer in the Department of Agriculture; ordinary folk cannot realize that, apart from machinery, an engineer can play a part in agriculture. His function is the technical administration of advisory services to the farmer and to act as consultant to the Department for engineering aspects of its functions.

**Department of Agriculture, Wellington.*

Engineering Services to the Farmer

Advisory services in engineering aspects of farming are available to the farmer through the Department in the same way as advisory services in any other aspect of farming, whether it concerns stock, pasture, crops, or management.

Engineering advisory services in the Department of Agriculture cover such items as roading, bridges, water supplies, drainage, buildings, machinery, processing, materials handling, or any items to which engineering procedures and techniques can be applied with advantage.

The Department has in the field specialist officers whose job is to advise the farmer on these things. There are drainage instructors stationed at Auckland, Palmerston North, Christchurch, and Invercargill who will do land drainage work for farms—on paper. The Department has not yet reached the stage of operating land drainage units as does Massey College. Drainage instructors advise entirely on land drainage and control of water table. There is a nominal charge for drainage planning work arranged to discourage frivolous inquiries.

There are machinery instructors stationed at Auckland, Palmerston North, Wellington, Christchurch, and Dunedin who will advise on any aspect of farming which involves engineering considerations. Where any aspect involves engineering beyond the facilities available to the machinery instructor, he will indicate where expert advice may be obtained. There is no direct charge for the advisory services of these instructors, but if expert engineering advice is recommended, this would, of course, be chargeable.

The Department also supplies, without charge, bulletins and drawings on engineering subjects. There is Bulletin 345: *Concrete,* which covers very simply most aspects of concrete usage, with a special section on lightweight concrete as applied particularly to building. There is Bulletin 344: *Farm Water Supplies,* in which water supply problems are very fully discussed. This bulletin also contains a special section on the construction of farm ponds. There is yet another bulletin, *The Disposal of Sewage from the Farm Homestead,* which gives complete details concerning the provision of septic tank drainage. Another bulletin is in the course of preparation dealing with the septic tank disposal of cowshed and piggery waste. These bulletins can be obtained on request from any office of the Department.

There also are constructional drawings which can be obtained on application to any machinery instructor. *Farm Loading Banks* gives complete details for the construction of both a straight and an L-shaped loading bank. The L shape facilitates simultaneous end and side loading. *Farm Bridges* gives complete details for the construction of stringer bridges with either steel or timber spans for 12 ft and 8 ft roadway widths and for spans of 6 ft to 30 ft. Another bulletin gives details of construction of a coke tray aerator for farms where the water supply contains iron. *Bulk Fertilizer Storage Bins* gives details of construction for multiple bins with sliding roof coverage. These bins are designed for building into a hillside to facilitate loading and are unloaded from the front. The capacity is from 10 to 20 tons per bin, with a maximum of four bins, which gives a possible storage capacity of 80 tons.

Hay Barns gives construction details of Dutch hay barns of two spans, 20 ft and 30 ft. Both spans are arranged for multiple bay construction. Capacity for the 20 ft span is 2 bays—1,000 bales, 3 bays—1,500 bales, and 4 bays—2,000 bales. Capacity for the 30 ft span barn is from 1,500 bales for two bays to 3,750 bales for 5 bays.

The drawings for a farm garage and workshop give constructional details for a building 26 ft wide and any length in multiples of 7 ft 6in. Positioning of windows can be arranged to suit requirements, and three alternative types of sheathing and two alternative types of roofing are provided for. Another drawing gives details of construction of roof trusses in radiata pine for buildings with spans from 22 ft to 38 ft.

There are also drawings giving details of construction of an *Implement Shed and Fertilizer Store*. They have been designed as one building, but can quite easily be constructed separately. The implement shed is 44 ft 5 in. × 20 ft, and the fertilizer store, which has been designed to hold 60 tons, is 15 ft 9 in. × 20 ft.

The "Know How" of Farm Engineering

Concerning the material available on "know how", first mention should be made of the publication, *Carpentry in New Zealand*, published by the Government Printer at 35s. It gives complete and concise construction and technical details; methods of procedure; the use of tools; preparation of specifications and plans; information on building permits; construction in weatherboard, brick

veneer, and stucco; concrete foundations; floor, wall, and roof framing; timber, its growth, conversion, seasoning, and preservation; and also interior finishing.

Before construction of most buildings is begun, but particularly of dwellings, most local bodies require the issue of a permit for construction to ensure that the proposed building meets with requirements of structural soundness, sanitation, fire hazard, etc., and, if it is a dwelling, to ensure that it is not below minimum standard requirements for human habitation.

Nearly all local bodies base their building by-laws on the New Zealand Standard Code of Building By-laws, which is published in eleven parts covering all phases of building construction. The part most useful for the farm builder is Part IX: *Light Timber Construction.*

When it is remembered that a standard specification sets out the minimum requirements which will be satisfactory for any building undertaking, the wisdom of conforming to the specification will be appreciated.

Part IX of the Standard Code of Building By-laws, which costs only 2s. 6d., should be on every farmer's bookshelf, because it gives much valuable information on the dimensions of various building components. For example, Table 2 gives minimum size of foundation blocks or piles, Table 3 gives minimum sizes and minimum spacing of studs for external walls and bearing partitions; Table 4 gives the sizes of lintels to openings. If the recommendations of this code are followed, local body by-laws are almost certain to be complied with.

Again, those farmers who regularly receive the *N.Z. Journal of Agriculture* will have access to a series of articles on farm building construction published from April to September, 1957. These articles were designed to cover building construction from the preparation of plans to interior finishing.

Now that indigenous building timbers are gradually being replaced with exotic timbers treated with preservatives, it is wise for timber users to be acquainted with the different preservatives, their qualities, and the characteristics they give to the timber to which they are applied.

Purchase of treated timber is not, as some imagine, a chancy business, as there exists a controlling body known as the Timber Preservation Authority, whose business it is to procure and maintain a high standard of timber preservative treatment. A booklet,

Timber Preservation in New Zealand, issued by that authority, and available from the Government Printer at 1s. 6d., not only sets out the function of the Authority but also gives a summary of approved preservative treatments. It contains extracts from the Timber Preservation Regulations 1955, which show how the consumer is protected, and also a list of registered timber treatment plants.

It may not be generally known that with some preservatives an increase in preservative retention increases the resistance of timber to decay under increasingly severe conditions. For the sake of economy, it is advisable to reduce the retention of preservative to a minimum safe limit to achieve adequate protection from destructive forces, and this varies in accordance with the degree of exposure of the timber to destructive forces. For example, the Preservation Authority specifies under "pressure treatment" that Tanalith C is approved for building timbers not in contact with the ground, subject to an overall retention of 0.3 lb/cu.ft, and for the same timber in contact with the ground subject to a minimum overall retention of 0.63 lb/cu.ft.

The suppliers of Tanalith preservatives recommend the retentions given in Table 1 when timber is used for various purposes. These values have been arrived at after prolonged testing, and can be specified when timber is ordered.

Choice of Construction Materials

The mention of treated timber leads to the consideration which should be given to the economics of the use of durable materials in building construction.

In farm building construction and also in the construction of private dwellings, the economic aspect is nearly always the deciding factor in the choice of structural materials. The durability or economic life of any building need not be greater than is warranted by the service for which the building is designed, but, on the other hand, greater durability ensures reduced maintenance costs.

There are so many factors which regulate the economic life of a building that it is difficult to choose structural materials which will provide a reasonable compromise between first cost and the subsequent cost of any maintenance necessary during that life. Obsolescence, the circumstances of the owner, unforeseeable future circumstances, hazard of fires, earthquake, flood, and other

TABLE 1: Recommended Preservative Retentions of Tanalith C for Various Timber Uses.

Timber Usage	*Recommended specifications*
Ordinary building construction *not* in contact with the ground	0.35 lb/cu.ft
Exposed to weather unpainted but *not* in contact with the ground (*e.g.*, fence battens)	0.40 lb/cu.ft
Uses similar to 0.40 lb (above), but where severe conditions make additional protection desirable (*e.g.*, seed boxes, freezing chambers, certain industrial uses)	0.50 lb/cu.ft
Ground contact timbers (*e.g.*, fence posts, poles, bridge decking, railway sleepers, underground cable covers, stadium seating, etc.	0.75 lb/cu.ft
Timbers in fresh water, wet industries, drains, etc. (*e.g.*, river control timbers such as sheet piling, groynes, flood gates, etc.)	1.00 lb/cu.ft
Timbers in salt water, cooling tower timbers, etc. (*e.g.*, wharf and jetty piles and bracings, sheathing timbers for boats and barges, sea defence works, and other timbers exposed to extreme decay and/or marine borer hazards)	1.25 lb/cu.ft

causes should receive just as serious consideration in the choice and use of structural materials as first cost, aesthetic values, utility, and all the other factors which combine to give the desired results. For example, where there is no adequate water supply, the construction of a building in timber does contribute to fire hazard.

Again, the construction of a dwelling with materials which require regular maintenance may be satisfactory for the years in which the owner's financial capacity can provide that maintenance, but the advent of age and decreased financial capacity may make the increasing cost of maintenance a hardship. This has been amply demonstrated in Great Britain, where many property owners have been forced to dispose of their holdings owing to changed financial circumstances and increasing cost of maintenance. Con-

sideration of these aspects is usually deferred until time brings them into prominence, when it is probably too late.

The choice of durable materials greatly affects the cost of insurance premiums; for example, the premium on a timber dwelling lined with plaster can be approximately 15 per cent. less than the same dwelling matchlined. Again, the premium on a brick or concrete dwelling can be as low as 64 per cent. less than a similar wooden structure.

Durable materials such as brick or concrete, when used for farm buildings where there are no fire-fighting facilities, can reduce the fire premium by approximately 60 per cent.

Savings obtainable in maintenance and insurance by the use of durable materials, also the value of protection against fire, considered over the calculated life of the building must be weighed against first cost in assessing the economics of their use.

Farm Fire Fighting

The mention of protection against fire leads to the consideration of the very large number of farm homesteads and buildings which have no provision for even first-aid fire-fighting. Most farms keep a first-aid box handy in case of an accident; is it not also logical to provide first-aid facilities in case of fire? Many farm buildings have been totally destroyed because fire could not be controlled in the early stages, and the cost of the provision of first-aid fire-fighting facilities is a very small premium to pay for protection.

First-aid fire-fighting facilities can consist of an adequate supply of readily available fire extinguishers. It is no use having fire extinguishers if they are not readily available, and their type should be suited to requirements—for example, a carbon dioxide extinguisher is best suited for electrical fires, carbon tetrachloride for petrol or oil fires, and the foam type for ordinary fires.

First-aid fire-fighting facilities can also be combined with a water supply system by the provision of an electric booster pump drawing from fire-fighting water storage. Sufficient water should be available to keep one or two $\frac{3}{8}$ in. fire hose jets supplied for half an hour. If first-aid facilities cannot control a fire in this time, it would probably then be beyond control except for full fire-fighting services. The provision of adequate water supply facilities and also a few fire extinguishers at salient points can result in saving many valuable buildings from destruction.

Carbon dioxide extinguisher (left), *carbon tetrachloride extinguisher* (centre), *and foam type extinguisher* (right).
(*Blocks by courtesy of Utilities Ltd.*)

There are many ways in which an ordinary farm water supply can be made suitable for fire fighting, and it is suggested that farmers who are beyond the reach of established fire-fighting services should give this point of fire prevention serious consideration.

Other Destructive Agents

Copper is usually regarded as a permanent building material, and copper valleys, flashing, downpipe, and guttering are considered to be there to stay. There is a case, however, where the small copper roof of a dormer was completely perforated by rainwater run-off from a tile roof. The perforation was most marked where there was water concentration at the joins in the tiles.

This destruction of what should have been a satisfactory roof was caused by the acidity of the water running off a tiled roof

covered with moss and lichen. The growth produced acid conditions in the rainwater sufficient to corrode the copper. This corrosion would have been prevented by either keeping the tiles free of growth or by the provision of a short, easily renewable guttering to carry the water away from the dormer.

The use of metals as building materials is usually not given the consideration which it should receive. It is difficult to understand why most people are antagonistic to the use of aluminium as a roofing material, particularly here in New Zealand, where we are subject to earthquakes. Admittedly, the importation of inferior quality corrugated aluminium roofing after World War II and the consequent unsatisfactory service it gave has resulted in a bad name for the material, but farmers do not condemn a fleece because they get crutchings from the same sheep. Corrugated aluminium roofing, if obtained in a suitable alloy and in the correct gauge and provided it is laid in accordance with accepted practice for the material, should be good, even without maintenance, when the building itself is old.

Its light weight and the consequent permissibly lighter structure required to support it result in a base-heavy instead of a top-heavy building, which is the case when a tile roof becomes wet. When a tile roof becomes wet, its weight is considerable increased as the tiles absorb appreciable amounts of water. The structure needed to support this weight adequately must also be heavy, which means weight at the top of the building. For stability under earthquake stresses, the weight should be at the base of the building rather than the top, and the use of lightweight aluminium roofing, and a consequent lighter roof structure, tends to achieve this.

Heating Farm Homes

There is one aspect to which attention must be drawn and it concerns the most important building on the farm. This building is the farm homestead and the aspect is heating.

From the broad view, the most important aspect of farming must be the welfare of the farmer, for, without him, there would be no farming, and anything which contributes to his welfare must be of equal importance. Yet, how often is the efficient heating of the farm homestead, to provide comfort during cold winter periods, given the serious thought it should receive?

The Handbook on the Insulation and Heating of Buildings (with special reference to dwellings) is a book which all, especially sheep farmers, should study. This is No. 18 of the Informa-

tion Series issued by D.S.I.R. The price is 5s. The author, Dr L. Bastings, is a prominent authority on the subject and has carried out wide research into heating problems over a number of years.

It is appropriate to quote from certain sections of this publication. In the foreword, W. H. Ward, Director of Dominion Physical Laboratory, says: "Far too many people think that the work of scientists is remote from ordinary life. This handbook tells a story of science being applied quite directly to every one of us. We all look on 'indoors' and comfort as synonymous, and we can't be comfortable if we are cold, damp, or sitting in a draught."

Dr Bastings himself says: "When a man buys or rents a house in which to live, there are certain fundamental requirements which he expects to obtain. The house must be sufficiently watertight to shelter him from the rain, hail, and snow; it must possess strength to resist high winds and other normal external forces; it must present a reasonably low fire hazard; lighting, both natural and artificial, must conform to an accepted standard; a minimum of sanitary, cooking, and heating conveniences must be installed or capable of being installed easily; and potential maintenance and repair requirements must not be unreasonably heavy.

"In normal times, any house showing marked deficiencies in any one or more of these respects would be rejected by a prospective occupier.

"There are, however, a few less obvious requirements which actually may prove as important as those just mentioned, but which generally pass unnoticed, either through lack of knowledge or through lack of experience of their importance.

"Among the less obvious but very essential requirements are the following:

"(1) The house should be naturally warm in winter and cool in summer; and should not be difficult or expensive to heat to a comfortable level in cold weather.

"(2) The interior of the house should normally be reasonably dry; linings, furnishings, clothing, etc., should never become damp or mouldy.

"(3) Ventilation without draughts should be adequate for comfort under both summer and winter conditions.

"To those who have extensive experience of living in different types of houses, it is well known that some types are naturally much warmer and cheaper to maintain in comfort than are others.

But to the majority of people the differences are not obvious to the eye. The difference in monetary value between the two extreme classes of houses is vast. Yet this feature may prove more expensive to the occupier than defects in the roof protection or inadequacy in the storm-water drainage.

"The majority of people plan to provide heat for their domestic comfort without taking any account of how effectively or how wastefully the heat will be utilized."

Farmers would not tolerate a leaking water tank, especially if the supply of water had incurred pumping charges. Yet many are content to occupy dwellings which leak heat as a perforated tank leaks water, and heat incurs charges for its production. Good insulating materials are available which, if judiciously applied to either new or old buildings, can play a big part in, as it were, plugging the leaks and making the dwelling reasonably heat tight.

Some heat will, of course, always be lost through uninsulated surfaces such as windows, but much saving can be achieved by the elimination of avoidable losses.

DISCUSSION

Q:: *Why was the emphasis on aluminium and not on galvanized iron?*

A:: The thought behind my remarks on the use of aluminium roofing materials was the use of durable material. Corrugated galvanized iron is a corrodable material, surface protected with a coating of zinc. As the durability of the base material can be no better than that of its protective coating, galvanized iron has a relatively short economic life as the zinc is subject to weathering. Corrugated aluminium roofing of the correct alloy, while also being a corrodable material, has different corrosion characteristics from either the protective zinc coating or the base steel of corrugated iron. Characteristic corrosion of aluminium is by pitting and corrosion becomes self-stifling, therefore complete perforation or failure of the material to perform its function can be avoided by the use of heavier gauge materal. It must be stressed that aluminium roofing can be satisfactory only if used in a suitable alloy and gauge and laid in accordance with accepted practice for the material.

A MEMBER: On two buildings in the Wairarapa both roofed partly with iron and partly with aluminium, a gale stripped all the aluminium off and left the iron intact.

MR EGGERS:: This was probably due to bad workmanship. Aluminium nails, with which the material must be fastened, are relatively soft and must be driven carefully to fasten pre-drilled sheets, otherwise they bend and cannot be driven home. Again, 1 in. sarking, if used, is unsatisfactory to fasten aluminium to as the nails do not get their full holding. The roof structure must be designed to suit the sheathing material it is required to support.

Q:: *The Railways Department reports that unpainted iron is the best roofing material. What does the speaker think?*

A:: I agree for short-term construction. A shed that is required for only 5 to 10 years and would then be scrapped could be so roofed but for a building that represents a capital investment, I would choose the material which gave durability without maintenance.

Q:: *If fire-fighting equipment is provided, is the fire insurance premium reduced?*

A:: I cannot answer for all insurance companies, but most companies of any repute make provision for a reduction of premium for both durable materials and the provision of fire-fighting facilities. Conditions in each case must, of course, be in accordance with fire underwriters' requirements.

A MEMBER:: My experience in Hawke's Bay was that there was no reduction in premium.

A MEMBER:: I went to the trouble of installing high-pressure equipment and it made no difference to the premiums.

Q:: *How does a farmer find out where he can obtain proper aluminium roofing materials?*

A:: While all the large aluminium companies have trade names for their roofing materials which can usually be relied on, the supplier should be able to give a guarantee that the material complies with the British Standard specification for a particular alloy. The alloys suitable for use as roofing materials are listed in New Zealand Standards Institute publication C.P.8. If a farmer is in doubt he should always apply to the local machinery instructor of the Department of Agriculture.

Q:: *Would the suitable material have a Standard Institute stamp?*

A:: Not a New Zealand Standards Institute mark. It may possibly have a British mark but usually the trade name is stamped on each sheet and if the alloy marketed under that trade name is guaranteed this could be relied on.

Q:: *Which is the best preservative for home-milled timber, creosote, dieseline, or no treatment.*

A:: Although creosote is one of the best-known wood preservatives, and dieseline is also a temporary preservative, treatment of home-milled timber with either is temporary, as only surface treatment can be given under home conditions. For permanent preservation, timber must receive complete penetration of the preservative. Surface penetration provides a protected outside layer only and destructive forces can still reach the unprotected inner layers through cracks and shakes. If preservative treatment is required, it is better to send the timber to the nearest treatment plant registered with the Timber Preservation Authority. With their installed equipment they will be able to ensure complete penetration of any preservative applied.

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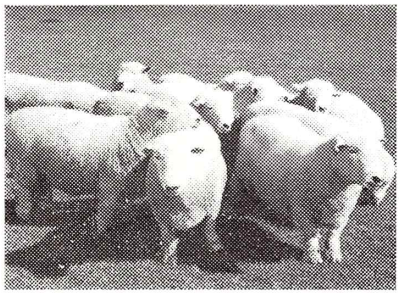

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RECENT DEVELOPMENTS IN WOOL RESEARCH

G. A. WICKHAM*

THE LAST FIFTEEN YEARS have seen outstanding developments in the technology of textile fibres. This has particularly been the case with synthetics where a large research expenditure has produced a return in terms of such new fibres as Terylene (and its American equivalent, Dacron), Orlon, Dynel, and Ardil. These fibres, unlike the earlier developed rayons, are not low priced. They owe their increasing popularity to certain characteristics in which they have proved more desirable than the older textile fibres. While their use in blends with wool is increasing, the synthetics have not as yet encroached really seriously on wool markets but, with much research at present being focused on the development of fibres with chemical structures akin to wool, new synthetics having most of wool's desirable characteristics could provide a greater challenge.

In an attempt to maintain the present favourable position of wool in the textile world, research programmes are being increased. The Australian C.S.I.R.O. is providing a lead to the rest of the world in this respect. A primary aim of much of this research is to consolidate knowledge of the growth, structure, and behaviour of wool fibres. Greater knowledge of these subjects should allow the formulation of new ideas which, after experimental testing, may improve production methods.

Wool research can be arbitrarily divided into a number of fields —wool biology, wool chemistry, wool physics, and wool technology. Sheep farmers will, no doubt, be more interested in wool biology, the study of the sheep as a wool-producing machine. The ultimate aim of the wool biologist is to bring about improvements in wool production by treatments which act through the sheep, but at present, since knowledge of the basic processes underlying the production of wool fibres by the sheep is so meagre, most of the work is of a fundamental nature and of less immediate commercial importance than some of the findings in other fields. It would be wrong to think that the only research that can help the sheep farmers is that aimed at increasing the quantity or quality of the wool leaving the farm. Decreases in manufacturing costs or increases in the price of finished wool fabrics will affect raw wool prices markedly.

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Wool Growth

Within the last five years ideas on the processes involved in the production of a fibre by the wool follicle have begun to crystallize. This has largely been due to new techniques involving the use of radioactive tracer substances and chemical stains.

The wool follicle consists basically of a tube, one-fiftieth to one-tenth of an inch long, opening on to the surface of the skin. Figure 1 is a simplified diagram of the structure. At the basal end there is a swelling known as the bulb. From the cone-shaped papilla which is situated in the bulb, round cells bud off, the process being rather similar to the budding process in yeasts. These cells are forced up the follicle by the pressure exerted by further budding from the papilla. During their passage up the lower regions of the follicle the cells become elongated as shown in Fig. 2. This elongation is perhaps due to a squeezing effect

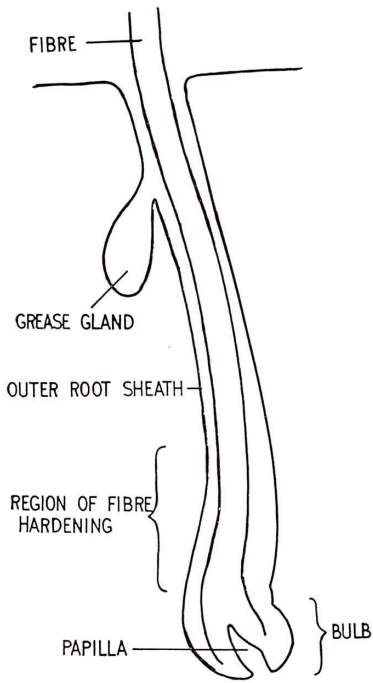

Fig. 1: Diagrammatic representation of the wool follicle.

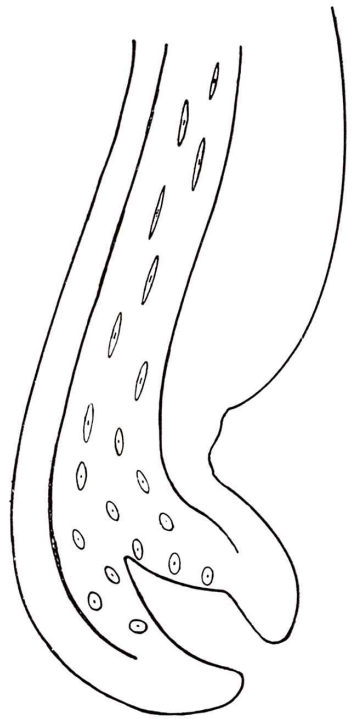

Fig. 2: Change in cell shape in the follicle.

by the follicle wall, the outer root sheath. While the cells are in this elongated form, they harden and become fixed in shape, probably due to the entry of a sulphur-containing compound into the cell protein. This hardening can be likened to the vulcanizing process used to harden raw rubber. Rubber in its natural state is extremely soft and plastic. Treatment with sulphur renders the rubber harder, the degree of hardness being dependent on the amount of sulphur added. As in wool, the function of the sulphur is to bind the individual chemical units together. Imagine a number of thin strips of timber. If each strip is not firmly connected to the adjoining strips they can readily be bent. If, however, the strips are firmly bonded together by screws, it is much more difficult to bend the timber. In the wool fibre sulphur acts in a similar manner to the screws, disulphide bonds holding the protein units together.

Another recent discovery of wool biologists is that nutrition prior to and immediately after the birth of a lamb affects the number of wool follicles laid down in the skin of that lamb. The lamb may ultimately grow to the same size as others getting better early nutrition, but the number of follicles which develop is less than if it had been well fed. There are indications that the adult fleeces produced by these lambs will be somewhat coarse, probably because there are fewer follicles to share the nutrients in the skin.

Advantages of Synthetics

For the textile manufacturer, synthetics have an advantage in that orders can be sent out for a fibre of a certain chemical structure having certain exact measurements. When ordering wool, however, the manufacturer has much more difficulty in defining his requirements because almost all wool is sold on eye appraisal. While experienced woolmen can predict manufacturing performance amazingly accurately, the manufacturer cannot be as certain about the ultimate end product when the raw material is wool as he can with the proven synthetics. It has been said that the woollen manufacturer recognizes a type of wool and can judge its performance from previous experience with similar wools. His knowledge of why a certain type of wool should manufacture well is far from perfect.

Increasing importance is now being given to the development of machines for the quick measurement of wool characteristics.

Recent developments are the airflow fibre diameter apparatus which quickly gives an estimate of the average thickness of fibres and the fibre length meter which indicates the length of the different fibres in a wool sample.

Because of the lack of knowledge as to why one type of wool will process better than another and because of the different systems of processing, it is impossible to learn from manufacturers what their requirements really are. Hence it has been extremely difficult to decide what we should strive for when selecting sheep for wool characters. The Textile Research Institute at Princeton, U.S.A., is now involved in a large-scale project studying the importance of certain fibre characteristics. Recently they have reported manufacturing trials comparing the performance of two Merino wools, similar in all characteristics but differing in fibre crimp. Results indicated that processing behaviour and fabric quality improve with increasing fibre crimp. Some Australian results seem to indicate, however, that staple crimp, which wool buyers generally assess, may not be closely related to fibre crimp and is not as important in manufacturing.

Perhaps the greatest advantage of the synthetics is their ease of care—in comparison woollen fabrics require much attention. Wool fabrics shrink if washed vigorously, they are prone to moth attack in storage, and they do not have wash and wear properties. The Australian wool textile laboratories have been giving these failings much attention. Of the hundred or more shrink-proofing treatments patented throughout the world their SI-RO-FIX process, although not perfect, is one of the best yet. This process involves cementing the fibres together with a resin derived from nylon waste. The Australians have also been able to show that Dieldrin at 0.02 per cent. of the weight of wool (total cost ½d./lb) makes wool resistant to moth attack even after repeated washing or dry cleaning. Dipping sheep in Dieldrin-containing dips also confers a degree of moth resistance on the processed wool.

Probably the greatest advance in wool technology in recent years is the durable creasing process using SI-RO-SET solution. The garment to be pleated is sprayed with ammonium thioglycollate solution and is steam processed for 20 seconds followed by a dry pressing. The mechanism involves a reversal of the hardening process which occurs in the follicle. When the wool is treated with thioglycollate, the disulphide bonds are destroyed and the wool becomes "rubbery". While the fabric is in this plastic condition

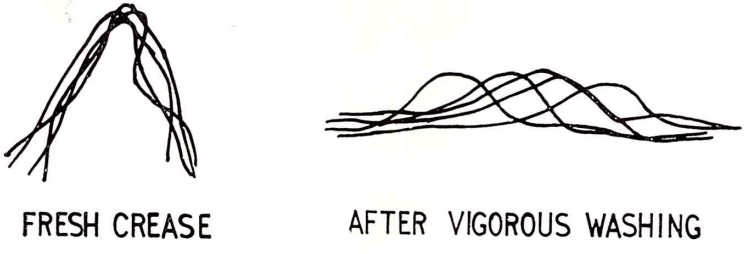

Fig. 3: Loss of the crease during vigorous washing of a wool fabric. The closely aligned fibres of the fresh crease are shown on the left, and the displacement of fibres after washing is indicated on the right.

the pleats are made, the garment is dried, and contact with the air brings about a restoration of the disulphide bonds, thereby hardening the wool. The process can be likened to removing the screws from the strips of wood mentioned above, steaming and bending the strips, allowing them to cool and then inserting the screws again while the strips are in a bent position. The end result is a permanent crease which is not destroyed by wetting. Unfortunately, woollen garments treated with this process do not have complete wash and wear qualities as the felting properties of wool tend to cause the individual fibres to move if washed vigorously, thus obliterating the pleats as shown in Fig. 3. If, however, the process is combined with perfect shrink proofing, it is possible that wash and wear properties may be achieved.

In conclusion, a further recent development in wool research should be pointed out, namely a tendency for an increasing proportion of the research to be carried out on Merino wools. While the problems are generally basically similar, many of the conclusions drawn for Merino wools may not be valid for crossbred wools. Complacency with recent developments must not be allowed to lead to continued neglect of research on cross-bred wool.

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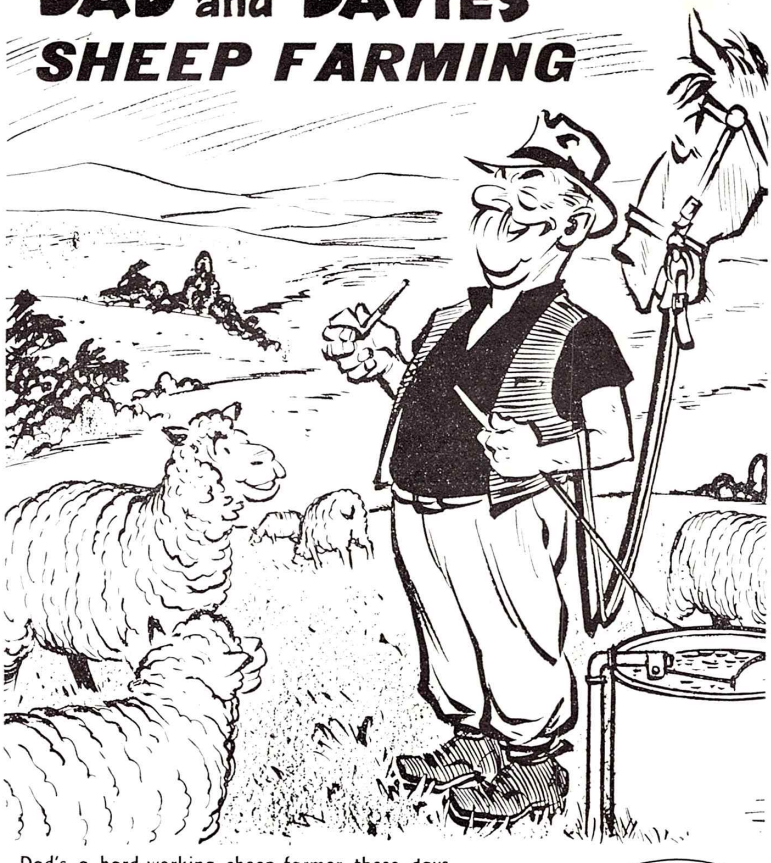

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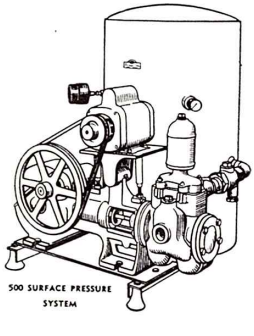

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SOME OBSERVATIONS ON AUTUMN FEEDING OF CHOUMOELLIER

G. S. ROBINSON*

THE USE OF CHOUMOELLIER as a supplementary feed crop has become firmly established in New Zealand, and the steady increases in acreage recorded over the last two decades are now tending to level out. It is a crop that seems particularly suited to North Island conditions. In fact, it is the only one of the major crops that has a bigger acreage in the North Island than in the South Island—70,000 acres out of a total of 110,000 for the whole of New Zealand. Despite the wide variety of soils and climatic conditions, choumoellier does well in most districts. It can be utilized for many purposes and over an extended period of time. The main uses are:

(1) For lamb fattening in late summer and autumn. This is most applicable to districts with dry summers.

(2) For milking cows in summer and autumn to supplement pasture.

(3) As a maintenance feed for sheep and cattle, when pastures are toxic following autumn rains.

(4) As a winter supplement until July for sheep, beef, and dairy cattle. Its use beyond this time is limited by its running to flower-head in the spring.

Requirements of a Safe Autumn Supplement

This paper is concerned with the effectiveness of choumoellier as a safe autumn supplement for sheep. The essential requirements of a crop for this period are:

(1) Reliability in producing a succulent feed during a period which often is extremely dry. Such climatic conditions are conducive to pest attack and a worth-while crop must be able to withstand such damage.

(2) Its feeding value must be such that stock will not go back in condition during the period they are off pasture. This demands a crop which retains a high nutritive value over an extended period, as the exact time of feeding is not known beforehand.

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(3) Palatability must be good enough to induce the stock to eat sufficient of the crop to supply their needs, even though they may have had a sudden change from all grass to all crop. This latter difficulty can be minimized by the earlier introduction of the stock to the crop to accustom them to it.

Looking now at choumoellier in the light of these requirements, it is easy to understand why it has been chosen by many farmers to provide autumn feed. It is most reliable, being more resistant to many of the pests and diseases which damage other members of the cabbage family. It is sufficiently high yielding by autumn to be economic to feed. It retains its feeding value through replacement of the older leaves by younger ones, and, in addition, it recovers well if shut up after autumn grazing.

There are, however, two difficulties associated with it. First, it requires ground that is well drained. The unevenness frequently seen in crops is generally due to over-wet soil conditions. This can be overcome in most instances.

Secondly, it is widely reported by farmers that choumoellier is unpalatable at this stage and stock tend to go back in condition when forced on to such crops. This same state of affairs is common at certain stages of growth to other members of the cabbage family. For instance, thousand-headed kale is often unpalatable until it has had a frost on it; swedes are also not readily eaten until they have matured in winter; while rape is well known to be less attractive to stock when in an immature condition and is much less satisfactory as a fattening crop.

Trials with Choumoellier

The remainder of this paper deals with some exploratory trials which have been carried out at Massey College over the last two seasons. These have sought to find out whether the stage of maturity of choumoellier in the autumn is in any way connected with its feeding value for stock at this time and its palatability.

The first trial was put down in the spring of 1957, when a series of replicated blocks of certified medium stemmed choumoellier was sown at two periods seven weeks apart. Some difficulty was experienced in getting a satisfactory seedbed for the early sowing on the heavy terrace soil, but finally it was sown on 22 October. The late crop followed on 13 December. The latter was a much more thrifty crop, and by the time grazing commenced

on 3 March, 1958, it was yielding 18 ton per acre as compared with 10½ ton from the early sown.

A line of sixty hoggets was divided into two equal mobs and placed on the crop, which was fenced into breaks of a size estimated to last approximately a week. No run-off was allowed, but water was provided.

The sheep were moved on to a new break whenever one or other group had defoliated their break, so that at no time were they forced to eat the stem of the crop. It was decided to follow this practice because it was considered that a farmer using chou-moellier at this time would not force his stock to clean it up but would be aiming to provide them with a safe feed of high quality.

A measure of the thrift of the hoggets was obtained by weighing them at intervals, generally whenever they moved on to a fresh break, provided they were dry enough. During the seven-week period they were on the crop, a note of whether they were scouring was also kept.

A similar trial was sown in the following season, but this time conditions for early seedbed preparations were ideal. The early plots were drilled on 15 October. The crop established rapidly and received no setbacks. The late plots were drilled on 11 December and they also got away to a good start. By the time stock were put on, the early crop was yielding approximately 35 ton per acre and the late crop 25 ton per acre. Weights were taken over an eight-week grazing period commencing on 16 March.

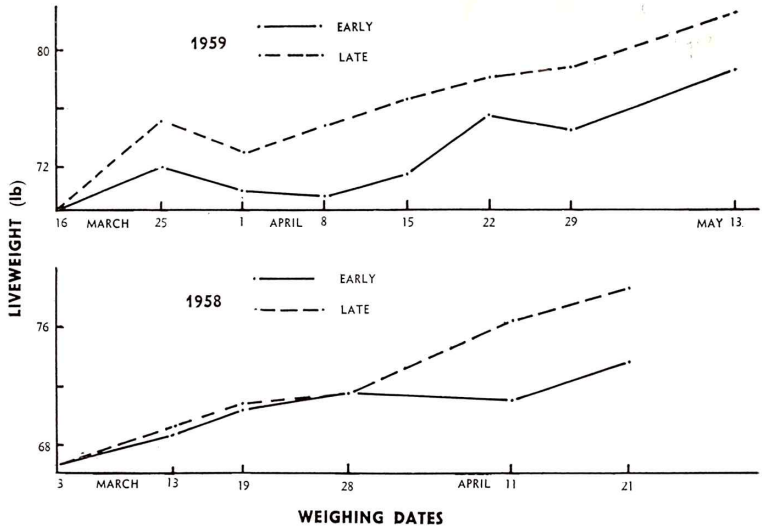
In both years, samples were taken periodically by Dr G. W. Butler, of the Plant Chemistry Division, to determine the nitrate content of the leaves and leaf stems.

Results

In 1958, all the hoggets survived the treatment, those on the late-sown crop averaging 12 lb liveweight increase and those on the early-sown crop 7 lb liveweight increase for the seven-week period.

In 1959, a rather similar end result was obtained—namely, 13½ lb increase from the late-sown crop per head and 9½ lb increase from the early-sown crop. In 1959, two sheep from the early-sown group died near the beginning of the grazing period.

The liveweight increases are not as good as one would expect from pasture at this time of the year, but are better than the



Lamb weights for 1958 and 1959 recorded during the grazing of early and late-sown crops of choumoellier.

appearance of the stock indicated. They did not always appear to be thriving, and took some time to settle down and eat very much. In both years, as commonly happens when farmers use crops in the autumn to avoid toxic grass, the weather became wet, with the result that the stock on the choumoellier were wetter than those on pasture and this did not add to their appearance.

On each occasion, the late-sown crop gave the better results, despite the fact that when grazed it appeared to be more immature. In 1958, the difference did not show up until nearly a month after grazing commenced, not until rain had reduced the soil moisture deficit to a low figure. This year the weather had broken just before grazing started, and the difference between the treatments showed up immediately.

These results are difficult to explain, as there was no noticeable change in the relative condition of the two crops. The late-sown crop, however, could possibly have been affected less by rain because of the better soil moisture position resulting from the two-month fallow prior to sowing.

It has been suggested that the early sown crop, being taller, would be less available to the sheep. However, in 1958 there was little difference between the height of the two crops, while in

1959, on some of the tallest breaks, there was no difference in the weight gains between the two groups of hoggets.

Another point of interest is that it was noticed in both years that parts of the crop were almost entirely neglected by stock. Samples taken from such areas in 1959 and tested for nitrate content revealed that the crop was at a lethal level for nitrate poisoning. Other samples taken from plants being grazed showed that nitrate levels were high over quite a long period. It would seem, therefore, that a more complete sampling for nitrate content should be made in any future extension of these trials to gain further information on this point.

In the meantime, the main points of interest are that moderate weight gains were obtained from grazing choumoellier in the autumn and that there is no indication that better results can be obtained by attempting to produce more mature crops through earlier sowings.

DISCUSSION

Q:: *What is the average stock carrying capacity of late- and early-sown crops of choumoellier?*

A:: Thirty hoggets took approximately a week to eat out a quarter-acre break. Both lots were shifted as soon as the leaf on one or other plot was finished. They were not forced on to stem.

Q:: *Were differences in nitrate levels in the choumoellier found during the period of the trials associated with differences in the liveweight of the sheep?*

A:: The crop were not sampled sufficiently frequently to be able to correlate liveweight differences with nitrate content. A more intense sampling procedure is envisaged for next year.

Q:: *Were the leaf to stem ratios determined for the choumoellier crop? Were there differences in nitrate levels between the leaves and the stems?*

A:: In the 1958 crops the leaf to stem ratios were in the region of 50:50; while in the heavier yielding crop in 1959 they were nearer 40:60.

DR G. W. BUTLER: The nitrate level of stems is generally two to three times as high as the level in leaves. In this trial, the sheep were eating very little stem because they were shifted on to the next break when the leaf was finished.

Q:: *Why did some parts of the crop have "lethal" nitrate levels?*

A:: Insufficient information was available to explain this.

Q:: *An explanation of the term "lethal" nitrate level would be helpful.*

DR BUTLER: The term "lethal" refers to the fact that the leaves contained considerably greater amounts of nitrate than the limit of 1.5 per cent. potassium nitrate on a dry matter basis, which is observed to be the level above which fatal cases of "nitrate poisoning" in stock may occur.

Q:: *Surely the sheep would lose liveweight over the period that the nitrate levels were high. Are species other than choumoellier high in nitrate at this time?*

A:: It should be borne in mind that the "lethal" levels of nitrate were found in isolated pockets of the crop and that these pockets were neglected by the sheep. Other portions of the crop were safely eaten, and in both groups increases in liveweight took place between weighings.

DR BUTLER: Ryegrass is observed to contain quite high levels of nitrate during the autumn flush period, the levels usually rising to 1 to 1.5 per cent. potassium nitrate on a dry matter basis.

Q:: *Is Mr Robinson going to try sampling the choumoellier for nitrate at an earlier period (mid-February) in view of the practice followed by many farmers of feeding their crop at this time in order to be able to sow down new grass in the autumn?*

A:: Yes, sampling will be undertaken from about mid-February onwards. The crops under discussion were specifically grown for feeding later than the questioner suggests. They were grown primarily as safe feed when pasture might be toxic in the autumn.

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THE PRESENT POSITION OF WHEAT GROWING IN THE NORTH ISLAND

R. H. SCHWASS*

AN IMPORTANT CHANGE took place in the wheat season just completed. Accurate figures are not yet available, but estimates based on sales of seed wheat and on observations by staff of the Department of Agriculture suggest that the Dominion acreage approximately doubled to some 136,000 acres; and that the North Island area increased by some 175 per cent. to about 12,500 acres.

Possibly the biggest relative increase here occurred in Hawke's Bay. District areas estimated for the North Island were 500 acres in the Waikato, 3,300 acres in Hawke's Bay, 1,700 acres in the Wairarapa, 3,400 acres in the Rangitikei, and 3,600 acres in the Manawatu.

Even if the average yield was below the 43 bushels per acre estimated by the Government Statistician, the North Island will have contributed some half a million bushels to the 13 million bushels needed this year.

This greater acreage in the past season is mainly due to the price increase to 14s. 6½d. per bushel for North Island milling wheat at a time when economic prospects for other lines of primary produce were becoming uncertain. In addition, of course, this wheat price was guaranteed and there was no possibility of the market being depressed by over-supply. Any wheat not up to milling quality faced a ready outlet into the poultry industry at prices which, if anything, were in advance of that offered for milling wheat.

Such considerations made wheat the most attractive of the alternative cash crops which could be grown. These included barley and peas for seed, and possibly potatoes and mangolds. In each case, there was a danger of a price depression from rapidly stepped-up production, while crops like peas and potatoes are risky to grow. Wheat, then, stood out as the obvious crop to help cushion some of the effect of lower returns from meat and wool.

Spring-sown Wheat

Spring-sown wheat in the North Island should be in the ground before the end of September. Crops sown later than this may run into dry conditions which will affect growth and maturity, and

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late-sown wheat is frequently low yi[illegible]g, w[illegible]h a [illegible]en-dency to pinched and small grain. Late-sown w[illegible]eat m[illegible]y a[illegible] when harvesting weather has become uncertain. Where sowing is delayed into October, the best course is a change to some other crop such as barley which can be sown more safely then.

There are several reasons why September sowing of wheat can be difficult. Wet soil conditions may interfere with cultivation so that a satisfactory seedbed cannot be prepared in time. Then again, it may prove awkward to divert labour from the seasonal jobs which loom so large to the work of preparing for and sowing wheat. Finally, in certain years at least, farmers will not be able to withdraw a pasture from grazing early enough to plough for wheat, and this will be more important under higher carrying capacities. An exception may occur on those Hawke's Bay farms where early lambing has been practised in recent years.

On the other hand, the position will be easier where wheat follows a winter forage crop. The present tendency to draft lambs at lighter weights lessens dependence on a summer fattening crop, and wheat represents an efficient use of such a paddock prior to autumn sowing of a new pasture.

Hazards in Wheat Growing

Weeds may result from the germination of dormant seed in response to cultivation, or from weeds which were not controlled in a previous forage crop. The efficient use of weedkillers applied at the correct stage of growth, which is the flag stage when plants have fully tillered, can give excellent control without deforming wheat plants or reducing yields.

Weeds may also be a problem in a wet season at harvest and the aerial application of sprays should then be considered. Ground machinery is likely to damage these mature crops.

Fungal diseases may be severe in certain seasons; in the season just passed, leaf and stem rusts and powdery mildew were very prevalent in the North Island and caused shrivelled grain and large reductions in yield. The dense foliage growth resulting from heavily-sown spring crops provides ideal conditions for the build-up of such pathogens. Certain soil-borne fungi, including the root-rot complex of *Fusarium* and *Helminthosporium* species, may also be prominent under high soil fertility conditions. They were one reason why Cross Seven wheat lost popularity in recent years in Canterbury, where soil fertility improvement has followed better pastures and stock management.

Insect Pests

Insect pests may also have serious effects. Ploughing of old pastures sometimes leads to damage in autumn-sown wheat from grass grubs overwintering in large numbers in the soil, but these will have little, if any, effect on spring-sown crops. The caterpillars of some night-flying moths, such as the army worm and the cutworm, may cause damage. Outbreaks have no apparent rhythm and are unpredictable, so that satisfactory control depends on early recognition and timely spraying. However, major infestations with army worms have occurred about February, when wheat is far enough advanced to escape serious injury. Army worm attacks have been more severe on pastures and barley crops.

In a dry spring, aphids may cause some damage to wheat and other cereals, but control by natural predators is usually efficient. The attack last season caused more alarm than harm.

A cheal bug, *Nysius huttoni*, is a major pest of cruciferous seedlings in parts of the Wellington province and is also one cause of "sticky dough" in flour. It is likely to be important only in the drier seasons. The wheat sheath miner, *Cerodonta denticornis*, and the Argentine stem weevil, *Hyperodes griseus*, are common and widespread in North Island pastures. These species have damaged wheat crops in the south and are potential economic pests. The common slug may do much damage to wheat in the seedling stage, and may also be harboured in wheat straw returned from the header to cause later damage in young autumn pasture. Wheat straw should be either baled or burnt.

Fertilizers for Wheat

Many field trials have examined the effect of superphosphate on wheat yields in the South Island. Over the past 30 years, the average response to 1 cwt of superphosphate has declined to about 1 bushel per acre, and the current recommendation is to drill 1 cwt per acre of this fertilizer with wheat only where there is a history of fertility depletion with crops or where the wheat follows pasture which has received little phosphatic fertilizer in the past. The position is not so clear-cut in the North Island where very few trials have been attempted.

The Department of Agriculture conducted two trials in the Rangitikei in 1957-58. These were in adjacent paddocks on the

same farm but had different cropping histories. In one case, wheat followed choumoellier after pasture; in the other, the wheat was a second successive crop following choumoellier after pasture. Where wheat was grown immediately after choumoellier, superphosphate gave a marked yield increase of about 50 per cent., but a much smaller response in the second successive wheat crop was of the order of 10 per cent. It was suggested that this result could be partly due to phosphate responses being limited by a nitrogen and possibly a potash deficiency in the second wheat crop, while weeds may also have reduced yields. Further trials are obviously needed.

In this respect, the soil testing service of the Department of Agriculture could be of much assistance. Samples should, of course, be taken before July so that results would be available prior to sowing.

These two September-sown trials also showed a yield response of some 10 per cent. in favour of a three-bushel per acre sowing rate over a two-bushel per acre rate.

Varieties for the North Island

Tainui has been the major spring-sown variety in the North Island for many years. Its baking quality is high, and farmers approve of its early maturity, its good yield due to large berries, and its non-shattering ears. However, it has one major fault—it may lodge badly on fertile soils and in wetter seasons. These lodged crops are difficult to harvest, and encourage stem rust.

Recently, Gabo has come into wide use as a replacement variety. Gabo was bred at the University of Sydney, first released in 1945, and has become a leading variety in Australia. Baking quality can be as good as Tainui, and Gabo does not readily lodge or shatter. It ripens a little earlier than Tainui, and trials conducted by the Department of Agriculture suggest that its yield is a little better than Tainui, particularly where this has lodged.

Weaknesses of Gabo Wheat

Farmers' experiences with Gabo have shown that it is not an ideal variety. Many commercial crops have some incidence of loose smut. Again, heads appear to fill a little unevenly so that ripe heads may contain undersized berries. The extraction rate at milling will be reduced if these are included in the final sample, so this potential source of complaint by millers should be overcome by careful screening at harvest and the disposal of seconds

for poultry feed. Both these faults should be avoided when New Zealand Certified seed becomes available in about two years' time. Present seed stocks will continue to be derived from Australian lines.

A more serious defect which cannot be corrected immediately is proneness to sprouting in the ear under damp conditions once the grain is ripe. This has been a major cause of dissatisfaction in the baking trade with some North Island flours in the last season or two, but is not restricted to Gabo. While a small proportion of sprouted grain in the flour may aid the baking process by providing more sugar for yeast fermentation and possibly improve the keeping quality of the loaf by giving a softer crumb, too much sprouted grain causes a sticky dough and many handling problems in the modern machine bakery.

Much wheat in the Manawatu district is grown on a share-cropping basis with reliance on contractors for cultivation and threshing. It may prove impossible to have the wheat threshed when ripe and sprouting could occur if such a standing crop receives rain. Any sustained increase in acreage could well warrant the outlay of capital in harvesting machinery.

Then again, Gabo is resistant to leaf rust and was thought to be resistant to the races of stem rust in New Zealand. However, the latter disease badly infected many crops in the wet season just past and caused severe yield reductions and much shrivelling of grain. It remains to be seen if this susceptibility will recur at all frequently. Finally, farm evidence suggests that the more erect and open growth of Gabo gives it a poorer weed smother than Tainui, and that Gabo is the more susceptible variety to bird damage.

Despite these defects, Gabo remains the most suitable variety for spring sowing in the North Island and will continue to fill the gap until a better one is bred or imported.

Other Wheat Varieties

Two interesting new varieties are the high-yielding, multi-parented Arawa and Aotea released by the Crop Research Division at Lincoln. Arawa was a heading wheat to replace Dreadnought in South Canterbury and North Otago, but has been very widely grown elsewhere in the last two seasons. It is susceptible to both leaf and stem rusts and its quality is suspect. It is another variety which, like Gabo, is prone to sprouting in the ear.

Aotea is intended as a general replacement for Cross Seven, and the coming season will be the first in which sufficient seed is available for full commercial use. It is susceptible to leaf rust and though it has some resistance to stem rust, yields could be reduced heavily under severe infections. Aotea has short straw, and is a little poorer in baking quality than a good line of Gabo.

The Department of Agriculture is planning trials to assess the value of Aotea for spring-sowing in the North Island. Aotea could well replace Cross Seven grown in the Wairarapa, but it may not be so suited as Gabo or Tainui elsewhere.

Acknowledgement

It is a pleasure to acknowledge that information was freely supplied by L. G. Copp of the Crop Research Division, I. D. Sanders of the Wheat Research Institute, and R. H. Scott, K. Cottier, and J. A. Graham of the Department of Agriculture.

DISCUSSION

Q:: *Is Gabo wheat superior to other varieties under very dry conditions?*

A:: In one Wairarapa block trial, Tainui yielded 41 bushels per acre but Gabo gave only 16 bushels—its yield was much affected by drought. Apart from this case, I know of no evidence to suggest that Gabo's response to dry conditions is much different from other varieties. Its rather earlier maturity could give it an advantage over Tainui in some seasons.

Q:: *Why is most North Island wheat spring sown rather than autumn sown? What is the difference in yield between the two times of sowing?*

A:: I think this is mainly a matter of a seven-month growing season as against a full year's use of the paddock. Autumn-sown wheat in the North Island is largely confined to some crops in the Wairarapa. Spring-sown plants do not tiller so freely as those sown in autumn, and this is overcome by using a sowing rate of some 3 bushels per acre in the spring. Yield would depend more on growing conditions and season than on time of sowing.

COMMENT:: A Wairarapa farmer observed that he had obtained higher yields from autumn sowing.

COMMENT:: Another Wairarapa farmer observed that on his farm Gabo wheat was more suitable under wet ground conditions than other wheat varieties.

Q:: *In view of the high cost of spraying, how badly damaged should a crop be before it is worth while spraying against aphids?*

A:: Because control by predators is very efficient, control by spraying should aim at the early stages of infestation when damage can be severe in crops 6 to 9 in. high, as in the last season, before predator populations build up. Advice on the advisability of spraying should be sought from Instructors of the Department of Agriculture.

PROGRESS ON EXPERIMENTAL WORK ON IODINE AND ANTITHYROID SUBSTANCES IN PASTURE SPECIES

D. S. FLUX,* G. W. BUTLER,† and A. L. RAE*

IT IS WELL KNOWN that deficiency of thyroid hormone can cause animals to grow abnormally slowly and to cease to reproduce. Lowered production of this hormone can be caused in a number of ways, two of the most common being too little iodine in the diet and the effects of substances (called goitrogens) which interfere with the working of the thyroid gland.

In recent work at Massey College and the Plant Chemistry Division (D.S.I.R.), it was found that a goitrogenic compound produced in animals eating white clover did affect the thyroid glands of guinea pigs and rats. This compound cuts down the ability of the thyroid gland to pick up iodine which it needs to make its hormone(s). Dr G. W. Butler and his colleagues at Plant Chemistry Division found, at the same time, that modern strains of short-rotation ryegrass contained a quarter to a fifth as much iodine as modern perennial ryegrass.

From the results of these pieces of work, it seemed possible that pastures containing some strains of ryegrass and white clover in combination might make animals grazing them deficient in thyroid hormone.

An experiment was set up to test this possibility in sheep and, in addition, to test whether the effect, if it existed, was big enough to cut down the growth rate of the sheep, their wool growth, their reproductive performance, or the growth rate of their lambs. This experiment is a joint effort by members of the Plant Chemistry Division and Grasslands Division of D.S.I.R. and members of the Sheep and Dairy Husbandry Departments of Massey College. In addition, a number of people belonging to other research sections have obtained material or information from it.

In the experiment, sheep were grazed on pastures consisting of perennial ryegrass (higher in iodine content) or short-rotation ryegrass (lower in iodine content) grown either as single species

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or together with pedigree white clover containing the substance which produces the goitrogen). Half the sheep in each group were treated with iodine which would have counteracted any effects of low iodine uptake because of the pasture. Ewe lambs were put on paddocks early in the winter and kept on the same type of pasture until after their first lambs were weaned, about 22 months later.

The comparisons between the different kinds of pasture were spoiled to some extent by facial eczema in the perennial ryegrass-fed sheep, and by short-rotation ryegrass alone doing badly in the summer. But within each kind of pasture the comparison between the performance of the sheep given extra iodine and the others gave a good indication whether the pasture affected the sheep by reducing thyroid hormone output.

The weights of the thyroid glands (which become enlarged if thyroid hormone production is below optimum) showed that the sheep on the pastures containing clover—both short-rotation ryegrass and perennial ryegrass with clover—did have some difficulty in taking up sufficient iodine from the pasture. The same effect was seen in the thyroids of the lambs raised by the ewes on these pastures. However, it appears that the effect was not sufficiently great to affect the growth rate of the animals or their rate of wool growth or lambing percentages. Nor was the growth of the lambs affected. It is perhaps worth commenting that the best lamb growth was on the short rotation/white clover pasture, but this did not appear to be related to thyroid activity.

In considering these results, it must be remembered that the two years over which the experiment was run were "non-goitrous" years. In some years in the Manawatu a high proportion of lambs and calves are born with enlarged thyroid glands; in others this does not occur. The reason for this variation from year to year is not known, but it is likely that the effect of "goitrogenic" white clover, especially if combined with a low-iodine containing strain of ryegrass, may be much greater in other years than it was in the two years over which the experiment was run, and for this reason the experiment is being continued.

In conclusion, it should be made clear that the type of effect which might be caused by such pasture combinations is not necessarily a lot of lambs born dead with huge thyroids, which occurs in some outbreaks of goitre, but a less spectacular one which might result in cutting down the productive performance of sheep by a small but economically important amount.

DISCUSSION

Q:: *Would the authors comment on the relative goitrogenicity of the brassicas (particularly choumoellier) and white clover? Could this account for Mr Robinson's low lamb growth rate?*

A:: We have no knowledge of the relative effectiveness of the two types of goitrogens. Even if they were compared in experiments the comparisons would be of doubtful value as the effectiveness of both types might vary in different circumstances. We do not know if goitrogens in the choumoellier adversely affected the growth rate of Mr Robinson's lambs, but they may have done so.

Q:: *Is iodine supplementation needed for sheep in the Manawatu area?*

A:: It seems in some years it could be of value, but not in all years. We do not know yet how to pick the years in which iodine intakes are likely to be deficient.

Q:: *What is the best way to give iodine to sheep?*

A:: As iodate in a lick. Iodide disappears too rapidly from licks. In the present experiment, injections of iodinated poppy seed oil were used, but this would not be a suitable method for sheep intended for human consumption.

Q:: *Could iodine be given as a drench?*

A:: Yes. The Department of Agriculture has recommended dosing in this way for pregnant sheep being grazed on kale.

Q:: *Are iodine-deficient areas clearly defined locally?*

A:: They are not very precisely defined, but in general the Manawatu-Wanganui area is marginally iodine deficient. This does not hold, however, for the coastal sand country. Soils which have been extensively water washed are likely to be deficient, while those of volcanic origin are normally not deficient.

Q:: *Has any work been done on the goitre problem in Hawke's Bay?*

A:: A little. We know of no suggestion that iodine deficiency occurs in Hawke's Bay.

Q:: *Are coastal sands relatively high in iodine?*

A:: Yes.

Q:: *Has any work been done to show the effect on their productive performance of goitre in lambs?*

A:: Although it is known that extreme iodine deficiency causes lambs to grow badly or not at all, and perhaps to die, the degree of deficiency (or of thyroid gland enlargement) which just affects productive performance is not known. As was seen in the present experiment, apparently there can be some degree of thyroid enlargement with little or no effect on growth, wool production, or reproductive performance in sheep.

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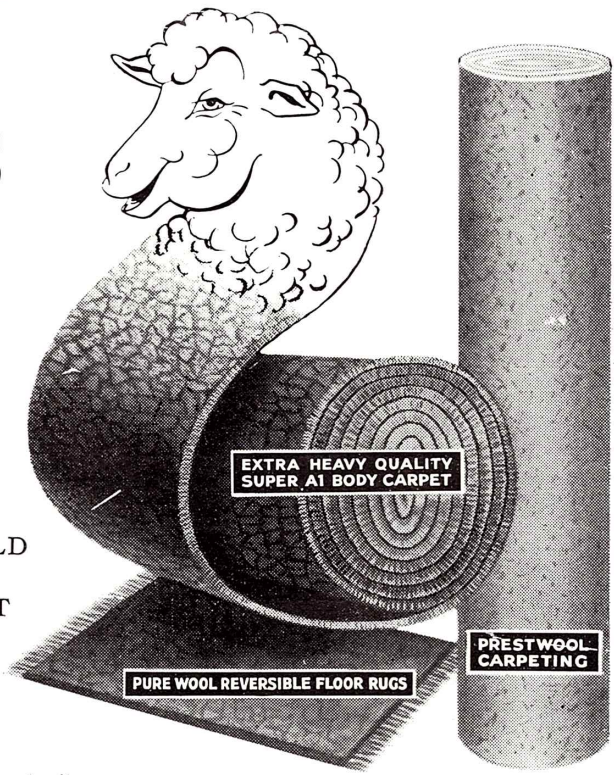

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INDEX TO ADVERTISERS

	Page
Australia & New Zealand Bank Ltd.	105
Bank of New Zealand	84
Barbour, J. H. & Son, Ltd.	192
Christie Electric Fence Service	69
Cooper McDougall & Robertson (N.Z.) Ltd.	168
Dalgety & Co. Ltd.	215
Davies, D. H. & Co. Ltd.	222
D.H.A. Rural (N.Z.) Ltd.	239
Elastrator Co. Ltd.	116, 117
Electro-magnetic Products Ltd.	181
Farm Chemicals Company	182
Farmers' Co-operative Wholesale Federation (N.Z.) Ltd.	216
Farmers' Industries Ltd.	191
Fletcher, W. & R. (N.Z.) Ltd.	202
Ford Motor Co. of N.Z. Ltd.	104
Hickson's Timber Impregnation Co. (N.Z.) Ltd.	94
Imperial Chemical Industries (N.Z.) Ltd.	118
International Harvester Co. of N.Z. Ltd.	70
Ivory Spray Chemicals Ltd.	93
Levin & Co. Ltd.	106
Mannings Ltd.	28
Marathon Rubber Footwear Ltd.	147
Massey Agricultural College	228
Nathan, Joseph, & Co. (N.Z.) Ltd.	83, 127, 148
Price, W. H. & Son Ltd.	59
Reckitt & Colman (N.Z.) Ltd.	26
Sargood, Son & Ewan Ltd.	71
Satterthwaite, A. M., & Co. Ltd.	16
Shell Co. of N.Z. Ltd.	72
Summit Products Ltd.	201
Tasman Vaccine Laboratory Ltd.	128
Tattersfield Ltd.	238
Todd Bros Ltd.	60
Winstone Ltd.	27
Wright Stephenson & Co. Ltd.	40

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